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RADIO WORLD

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America's First and Only National Radio Weekly

2-TUBE PORTABLE

SQUEAL ELIMINATION

VALUE OF SHIELDS

OSCILLATORS FOR SUPERS

THE ADAMS-GRIFFIN SET

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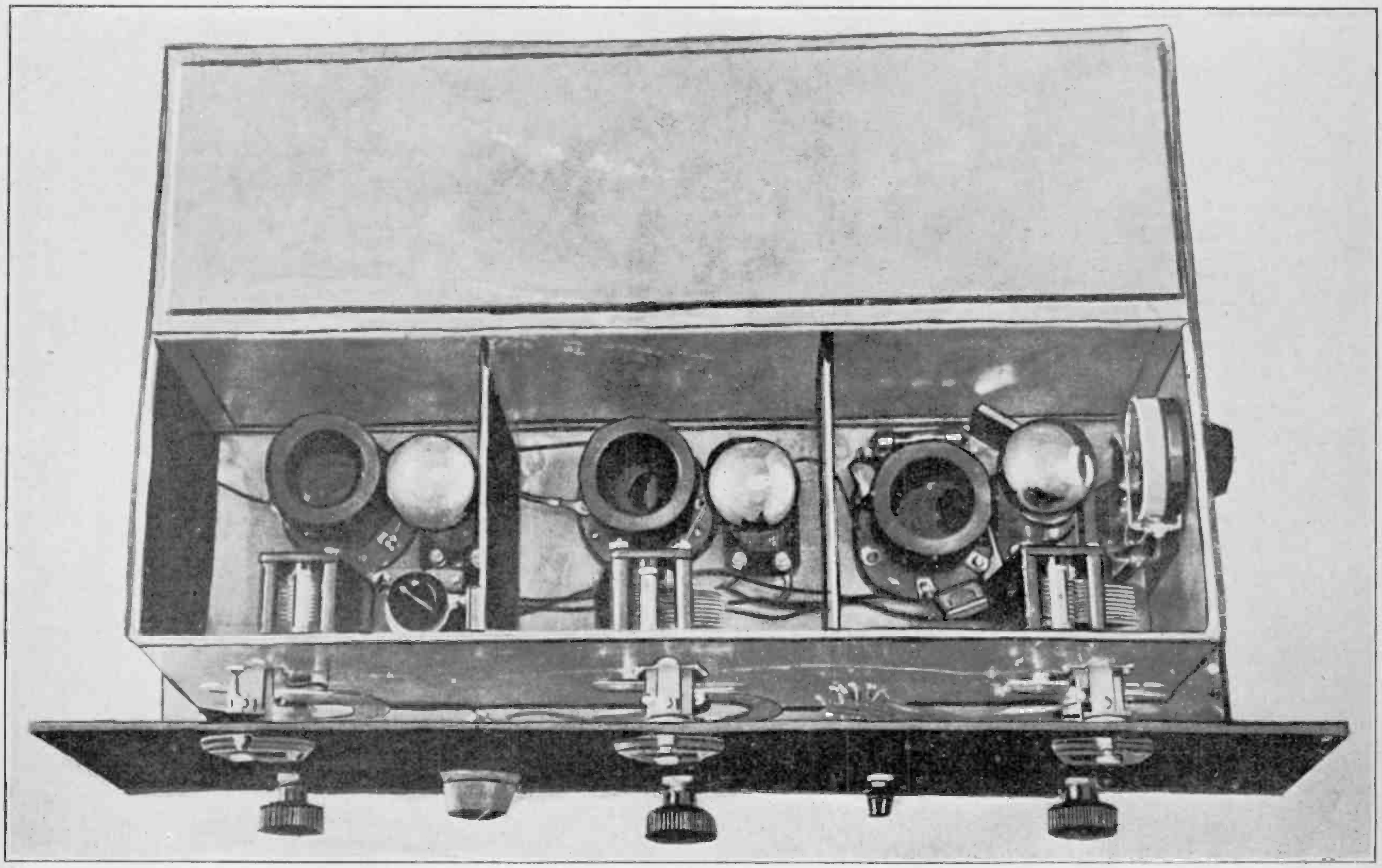

The Top View of the Shielded DX Set, the Adams-Griffin

GOOD SET DESIGN

Effect of Plate Resistance

PUSH-PULL OUTPUT

Selectivity of Loop Analyzed

SIXTH YEAR

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The Adams-Griffin
A Six-Tube Shielded DX Receiver

By Dana Adams-Griffin

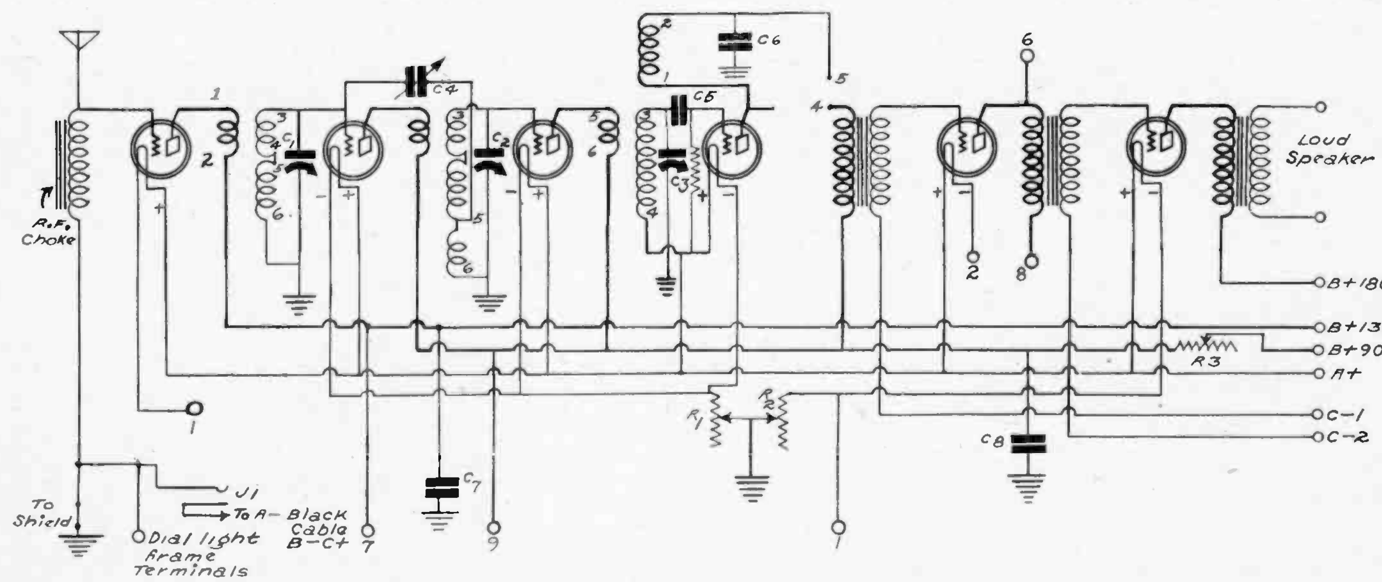


FIG. 1
The circuit diagram of the Adams-Griffin receiver, consisting of six tubes, with three shielded stages. The set is built with audio and untuned RF stage at rear

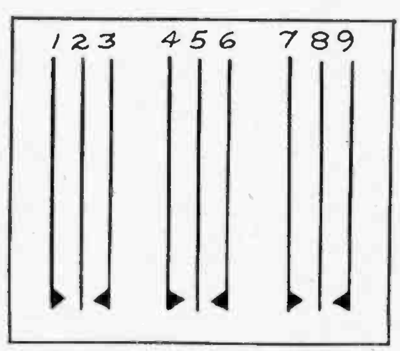
THE interference, which a short time ago was confined to the larger cities, has now become a national issue. Together with high quality, which is the foremost requirement in modern receivers, is the absolute necessity of a degree of selectivity heretofore unknown. Every real radio fan is a DX bug to some degree if his equipment enables him to cut through the local stations. "Dial fever" is an interesting hobby if results are forthcoming, but where local stations blanket things until after midnight, DX interest soon becomes dormant.

After several months of experiments and tests in over half a dozen of New York's so-called "dead spots," I can truthfully report remarkable results on the Adams-Griffin receiver (Fig. 1). Two outstanding ideas in radio circuits have been developed to obtain these results, which should interest every radio fan.

As shown in the diagram, the first stage is untuned. While the amplification of this stage is slight, the stage prevents radiation and keeps the capacity effect of the antenna away from the first tuned circuit, making matched dial readings possible.

Why Shielding Is Used

The two tuned stages and the detector are shielded to suppress powerful local signals. It will be noted that there is a tickler coil in the plate circuit of the detector. This tickler is adjusted after the amplifier is balanced so that the detector is brought almost to the oscillating point. By means of a variable resistance, which is a panel control, the B battery voltage on the tuned stages and the detector is variable. When high waves are tuned in the efficiency of the tubes is raised to



Front View of Switch Contacts Showing Numbers

maximum by raising the voltage. Going down the scale, the voltage is lowered to compensate for the natural increase in feedback. In other words, by means of the B voltage the tubes may be kept at peak efficiency at all wavelengths. With regeneration at the top on all three tubes, the dials are all razor sharp.

Alhtough KFI was tuned in on three consecutive Saturday nights in the suburbs of New York City, this cannot be used as a criterion of the sensitivity. However, 1,000-mile reception within 10 kilocycles of a number of 500-watt local stations is easy at 9 P. M. in the heart of the city at this time of the year.

The other important factor in the design is the quality of reproduction. More work has been done by engineers throughout the country on this point during the past year than on any other problem of design. It is safe to say that quality is no longer a problem, with good transformers, a —71 power tube, and 180 volts or more of B supply. However, to use the first AF stage alone for loud locals on the speaker, or for phones, results in distortion. This is the reason for the Yaxley No. 763 "loud-soft" switch. In the "soft" position the switch causes the use of the power stage with the output transformer and high B volage, with resultant fine quality, for one-stage work. On the "loud" position the first stage is cut in ahead of the power stage, thus making the normal amplifier. In this way it is impossible to overload the set.

Results Are Fine

At first glance perhaps the construction looks difficult. Of course the assembly is not conventional, but neither are the results. If the step-by-step instructions are followed in their proper sequence even the fan with a very limited experience should complete the job in six or eight hours.

The panel, drilled according to Fig. 2, is fastened to the baseboard by means of five ¾" wood screws. Next the dials, the Carter hi-ohm, and the interstage switch are put in position. Care should be taken that the "hair line" of the dial indicators is correct and the contacts of the switch should be in a vertical position. The Yaxley cable block is now screwed in place, as well as are the three screw eyes shown in Fig. 3. And now a little wiring is the next step, so heat up the iron.

A black Celatsite wire is soldered to the A minus lug on the cable block and run through the screw-eyes to one side of the filament switch on the Carter hi-ohm. The other side of the switch connects to

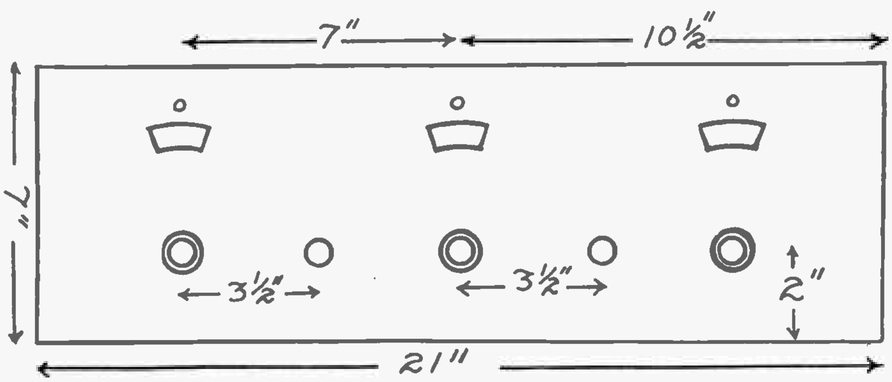


FIG. 2

one terminal of each dial light. A red wire is run from the A plus on the block to the other terminal of the lights. Connect the A battery to the set temporarily and see if the lights work when the volume control is turned on. The A circuit should be broken when the control is turned off.

Advice on Mounting

Now run a yellow wire from B minus on the block, through the eyes, to one side of the resistance on the volume control. A wire from the other side of the resistance to terminal 9 on the switch completes the wiring for a few minutes, as the shielding is next put in place.

The slots in the bars furnished with the dials should be fastened in a horizontal position with the center of the slots 2¾ inches above the baseboard. A one-inch machine screw is put in the right-hand side of each bar and two of the spacers furnished with the dials put on each one. These screws are put through the holes marked "A" in the shield and the can is fastened in place. The condensers, which are now mounted, should have the lugs on the stator plates on the bottom side for ease in wiring. With the rotors facing the left, it will be noted that when the condensers are placed in position, that the screws that hold the can go through holes in the end plates of the condensers. A nut on each of the screws together with the shaft set screw when the dials are lined up, hold the condensers firmly in place.

The can used by the designers is the Graymore 2-A shield which is completely drilled for this receiver. For those desiring to make their own shield the following will be helpful. The back of the can slides out to make wiring inside possible, and the top is hinged to the back. Two ⅜-inch holes are drilled in the right hand end of the can 2" from the rear for the rheostats. A ½-inch hole is drilled at the bottom 3½ inches from the rear in the right-hand end, and the two compartment walls, for the cable in the can. Two holes are drilled in the compartment walls for plate wires 1 inch from the rear and about 1½ inches from the bottom.

Connections To Be Made

Now mount all the tube sockets, coil sockets, and fixed condensers. The binding post strip in the rear holds posts for the antenna, ground, and loud speaker, and is mounted on two brackets. The three-plate neutralizing condenser and the audio transformers are omitted for the time being. The next step is the wiring of the filament circuits.

From the negative on one of the dial lights a wire is connected to the can. If a large soldering iron is not at hand, a lug with a nut and bolt will do the job on shield connections. As the shielding is automatically connected to the arm of both rheostats, as well as the rotors of the condensers no wiring is necessary at these points. The fixed end of the top rheostat is connected to the three A minus terminals of the sockets in the can, and also to terminal No. 6 on the first two coil bases. The fixed terminal of the other rheostat connects to the first radio and last audio sockets and to terminal No. 1 of the switch. Terminal No. 2 of the switch connects to the minus of the first audio socket. From the A plus on the cable block red wires are now run, one to the sockets inside and the other along the back of the can to the sockets outside. Connect the A battery again and see if all filaments light on the "loud" position of the stage switch, and all but the first audio on the "soft" position. All tubes should go out when the volume control is in the "off" position.

As A minus, C plus, and B minus are to be strapped together outside the receiver this leaves the B minus wire of the cable free. Accordingly, it will be used as B plus 67½ volts. This lead already runs through the resistance to contact No. 9 of the switch and it is now picked up at this point and run to terminal No. 6 of the detector coil base, the 1 mfd. condenser and terminal No. 2 on the third stage coil base.

Completing Battery Wiring

Next an orange wire is connected from the dark blue terminal of the cable block to the 1 mfd. condenser, and terminal No. 2 of the first coil base. All battery wiring for the radio and detector circuits is complete and the grids and plates should now be connected as shown in the diagram. The neutralizing condenser is connected to the grid wire of the second stage and to terminal No. 5 on the third stage coil socket. Terminal No. 4 is left blank on this socket.

A few slight changes in the coils are now in order before testing the radio frequency side. The first 110-A is used as manufactured in the second stage. The taps in the center of the remaining 110-A are unsoldered from terminals Nos. 4 and 5 on the coil and connected together and soldered to terminal No. 4. This leaves terminal No. 5 on both coil and base free for the tap at the eighth turn, which is now taken off and connected to terminal No. 5 on the coil itself. The 111-A is used in the detector stage. All the green wire in the slot at the bottom of this coil is unwound and 9 turns wound in the empty slot in reversed fashion. All but five turns on a side are removed from the rotor of this coil and the coils are finished.

Connect up the A battery and connect the minus of a 45-volt B block to A minus, and the plus to the yellow and dark blue leads of the cable. A 45-volt reading should be obtained on the first plate with the voltmeter negative on the shield.

Ready for Test

A variable reading of O-45 will be noted on the plates of the other radio stages, and the same thing on the detector if terminals 2 and 6 of the coil base are connected together *temporarily*. Check the circuit if these voltages do not show at the proper places and next mount the audio transformers.

Connect terminal No. 6 of the detector coil socket to the B terminal of the first transformer. The 135-volt terminal of the cable block is connected to terminal No. 7 of the switch. The light blue on the cable block connects to B on the output transformer, and the two C battery connections are soldered in the circuit. This leaves plate, grid, and switch connections to be made, but these are obvious in the schematic diagram. When these connections are completed, check things over for omissions and mistakes and then connect up the proper battery supply. Insert the proper tubes, connect the speaker, the antenna, and ground and the receiver is ready for broadcast test.

(Part II next week)

LIST OF PARTS

C1, C2, C3—Three Amsco .00035 S. L. T. condensers.
C4—One Precise 3-plate condenser.
C5—One Tiny Tobe .00025 condenser.
C6—One Tiny Tobe .001 condenser.
C7—One Tobe 1 mfd. condenser.
C8—One Tobe .1 mfd condenser.
R1, R2—Two Yaxley 6-ohm rheostats (16K).
R3—One Carter 200,000-ohm variable resistor and filament switch.
Two Silver-Marshall 100-A Coils
One Silver-Marshall 111-A Coil.
Three Silver-Marshall Coil Bases No. 515.
One Westinghouse Micarta panel, 7x21 x3/16 inches.
One Westinghouse Micarta binding post strip 2½x2½x⅛ inches.
One Graymore RF choke coil.
One Graymore 2-A shield.
Six Pacent sockets No. 83.
Two Pacent Superaudioformers No. 27-A.
One Pacent Superaudioformer No. 27-B.
One Yaxley Cable No. 660.
One Yaxley Switch No. 763.
Four Eby binding posts Ant., Gnd. and two loudspeakers.
One Amsco 5-megohm Grid Gate and mounting.
Three screweyes with ½ inch eye.
One baseboard 10x20x½ inches (plywood).
Thirty feet Acme flexible Celatsite wire in five colors.
Two lengths of bus bar.
Assorted screws, bolts, etc.

Why Some Sets Lack Pep

Every now and then you will run across a set, generally of the tuned radio frequency type, which, while made of good parts and with apparent neatness, lacks the pep that brings in distant reception and gives volume and selectivity.

Frequently this is caused by a large mass of metal, such as a variable condenser or an audio transformer, so placed that it is in the field of a coil. The lines of force from the coil strike the metal and much of the energy is lost. In the radio frequency stages, remember, you are dealing with minute currents and no matter how small a loss, it is manifested.

There are two methods of procedure in cases of this sort. You can either move the parts to different locations or you can adjust the coil so that its energy will not be lost. On the other hand, a small amount of loss is sometimes desirable. A certain very popular, moderate priced set locates its tuned radio frequency transformers directly on the backs of the variable condensers so that there will be enough loss to keep the set from self-oscillation without making any neutralizing condensers, potentiometers, etc., necessary.

Another cause of missing pep is high resistance joints, often due to poor contacts.

A Two-Tube Portable
That Gives Good Range on Earphones

By Hood Astrakan

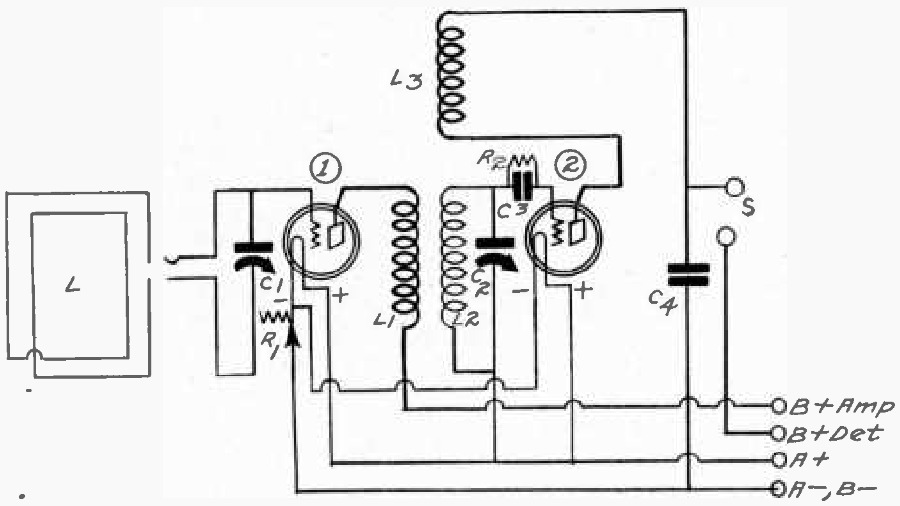


FIG. 1

Circuit diagram of a two-tube regenerative receiver suitable for a portable set for headset reception

THE camping spirit is already in the blood and those who feel the call of "back to nature" are planning their trips and deciding on their equipment. One of the first things that most of them will decide to take along is a portable radio set. That is now as important as the gun, the fishing rod and the tent equipment.

A radio set that is to be taken along on the trip to the woods must have one thing in common with all the other equipment. It must be light in weight. This fact precludes the use of storage batteries for heating the filaments of the tubes in the set. Dry cells must be used, and consequently dry cell tubes must also be employed in the receiver. The question of how many tubes to incorporate in the set is settled by the required sensitivity, or distance-getting requirements, or the set. That in turn is determined by the distance the camper intends to go from a broadcasting station.

There are now so many broadcasting stations scattered throughout the country that it is not possible to go outside a radius of about 200 miles from one station without being within that distance from some other station. Hence the set should be sensitive enough to receive the signals from such a distance.

Since a loud speaker cannot very well be taken along on a very lightly equipped trip, reception may be confined to headset operation. That requirement in turn puts a limit on the number of tubes necessary in the set. A two-tube receiver employing dry cell tubes and using regeneration fills the bill quite satisfactorily as to sensitivity, portability and headset volume.

A loop (L in Fig. 1) is used for inducing the minute ether wiggles to enter the set. This loop should be wound to tune the broadcast band with a .0005 mfd. condenser, C1. The loop preferably should be wound on a large frame to make it sensitive, but a large loop is not readily portable, unless of the folding variety. Loops of this type which fold up into a very small and neat package can be purchased in most radio stores.

The loop can also be made by the camper himself with the exercise of a little ingenuity. The essentials of a loop are about 90 feet of flexible wire and something to hold this wire. Of course the frame must not be made of metal, as this will absorb some of the energy that must be conserved for the tubes. Dry wood is good material. In a pinch the wire can be wound around wooden box.

The coupler between the two tubes is a three circuit tuner of standard make. It is best to purchase one of the smaller types which many manufacturers make, since space is an important consideration in a portable set. Since the circuit is regenerative, a high degree sensitivity can be obtained.

The secondary coil (L2) of the coupler should be wound so that it covers the broadcast band with a .0005 mfd. condenser, C2.

The grid condenser, C3, should have a capacity of from .0001 mfd. to .00025 mfd. The smaller value gives a greater sensitivity on weak signals, and is sometimes to be preferred over the larger standard value. The by-pass condenser, C4, should have a value of .001 mfd.

The tubes best suited to this receiver are the 3.3-volt, 60 milli-ampre tubes, known as the —99 type. With these tubes the common rheostat R1 should have a resistance of 25 ohms. This will afford adequate volume control as well as well as filament voltage control.

The filament voltage can be obtained from three No. 6 dry cells. These will give service for a considerable time. If extreme lightness is necessary, it is even possible to dispense with one of the dry cells, but the two used must be replaced more frequently than if three are used. It is even practicable to use three smaller dry cells, such as 4½-volt C batteries.

The plate battery need not exceed 45 volts, and this can be supplied by one of the small battery blocks obtainable. A couple of small 22½-volt batteries can be used.

The headset used should have a high impedance, because the impedance of the detector tube is quite high. Matching of impedances for greatest power output is of significance here, since the detector tube delivers power in this case and not merely voltage.

A suitable layout of the panel is shown in Fig. 2. The loop terminals are connected to two phone tip jacks placed in the lower left corner of the panel. The audio output from the set is taken out by connecting the headset to a similar pair of midget jacks placed at the lower right corner. The rheostat is placed centrally between the tuning condenser dials. The size of the panel need not be greater than 7x10 inches and may be smaller.

A small baseboard will be needed for mounting the two tubes. This can be a small strip of thin wood or hard rubber of suitable size.

The entire set can be mounted in a very small suitcase, the set proper at the top and the batteries at the bottom.

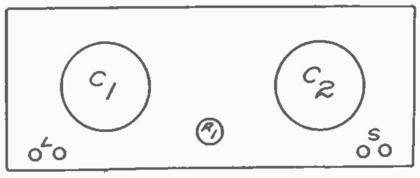


FIG. 2

LIST OF PARTS

L—One loop made of about 90 feet of flexible wire.
C1 and C2—Two tuning condensers of .0005 mfd. capacity.
L1, L2, L3—A small three circuit tuner to fit condenser C2.
C3—One .0001 to .00025 mfd. fixed grid condenser.
C4—One .001 mfd. by-pass condenser.
R1—One 25-ohm rheostat.
Two phone tip jacks.
Four binding posts.
Two dials.
Two X sockets.
A small baseboard and a small hard rubber panel.
Two —99 tubes.
Three No. 6 dry cells.
Forty-five volts of B battery.
One headset.
A suitcase or other container for set.

KDKA Short Waves Experimental Only

Pittsburgh.

While there have been rumors in broadcast circles that stations are taking up short waves seriously, as a definite part of their technical routine, KDKA announces that its short wave activities are confined exclusively to experimental work. The pioneer station "broadcasts" on a long wave and "transmits" simultaneously on short waves. At present KDKA is broadcasting on 309.1 meters and transmitting on 62.5 and 14 meters.

The experiments with short waves are giving the KDKA engineers many opportunities to perfect high frequency and modulating equipment, and at the same time to test the lower wave bands for carrying-power, losses and quality.

The 62.5 meter wave will be used again this Summer to maintain communication every Saturday night with isolated points in the Arctic regions, to which long waves penetrate very poorly in hot weather.

KDKA's 62.5 and 14 meter transmitters were booked for the last Presidential speech, which was broadcast through a chain of 42 stations. At that time the short waves were heard in England and Africa.

All KDKA transmitters are crystal controlled.

STATION LIST DEFERRED

The corrected and revised list of broadcasting stations in the United States, usually published in the first issue of the month, is omitted from the present issue of RADIO WORLD due to the almost daily changes of wavelength and power. Publication of the list will be resumed when practical.

Removing the Squeals

How to Improve Super-Heterodyne Sets

By John L. Barrett

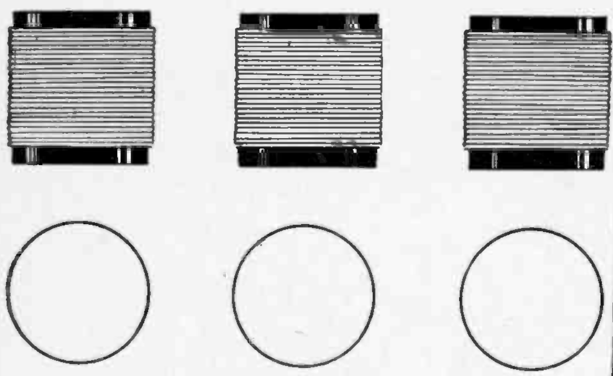


FIG. 1

This method of placing transformers, either radio or intermediate frequency, invites trouble and oscillation. They are placed side by side with their axes at right angles to the line which passes through their centers. Whether the axes are horizontal or vertical is all the same. Unfortunately this method is the easiest way.

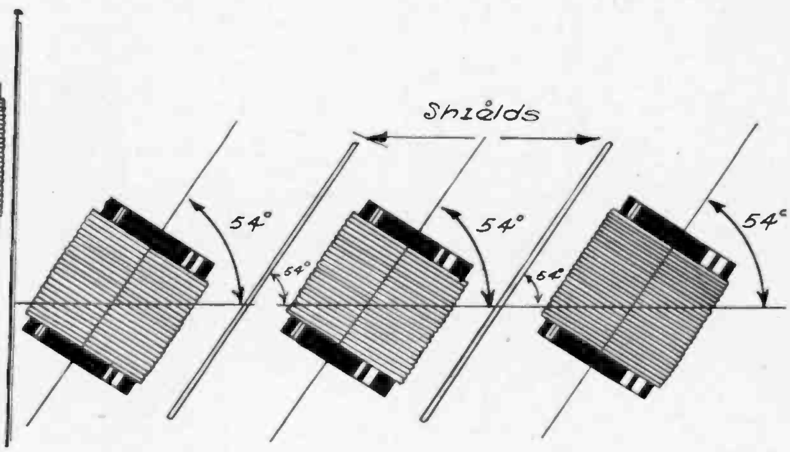


FIG. 2

This shows how transformers should be placed to avoid interstage inductive coupling and oscillation. They are placed parallel but their axes are inclined at an angle of about 54 degrees from the line joining their centers. The angle is approximate only and should be used as a basis for obtaining the required angle.

SOMETIMES trouble is met in Super-Heterodynes. Quite often in fact. Some of these troubles are inherent in the Super-Heterodyne, others are indicative of poor design. They may be classified in four groups. First, oscillation in the radio frequency tube or the first detector where it is preceded by RF; second, oscillation in the intermediate frequency amplifier; third, oscillation in the audio frequency amplifier; fourth, cross talk between two radio frequency waves.

When there is oscillation in the first detector the set squeals when the detector tuning condenser is turned, and the receiver is most erratic. It is difficult to tune in any station. This trouble is not encountered unless there is regeneration in the loop or first tuner. If there is a regeneration control all is well because the oscillation can be stopped. When there is a radio frequency amplifier ahead of the detector, the first two tubes may oscillate, and then it is difficult to control the regeneration because the feedback is usually of the stray variety. Stopping the oscillation is the cure for this trouble.

Oscillation in the intermediate frequency amplifier is probably the most frequent trouble in a Super, and it is the result of faulty design. The oscillation is, of course, due to regeneration in the intermediate stages. This may be caused in three ways. First, capacity coupling between the parts of one stage and those of another; second, by inductive feedback between one transformer and preceding transformers; third, by the common impedance in the B voltage supply.

Effect of High Frequency

Capacity coupling between two stages is not serious when the intermediate frequency is low, but sometimes a high frequency is used, and then the coupling may be sufficient to cause oscillation. It may be eliminated by shielding the different stages and grounding the shields. This removes the coupling between the parts themselves but does not remove the coupling through the plate to grid capacity. The effect of this can be eliminated by resorting to neutralizing as is done in the Neutrodyne.

Inductive coupling is the most serious and most frequent. One transformer acts as a tickler to a preceding transformer and oscillation is almost sure to follow. The trouble is due to improper design, placement and connection of the intermediate transformers. It is a surprising fact that many intermediate transformers in the past were so designed it was almost impossible to avoid inductive feedback and oscillation when they are used. This can only be due to a failure of the designers to visualize what is taking place about air core transformers, or to an aversion to deviating from the simplest way of making the transformers. They should be made so that they can readily be mounted at right angles, either geometrically or electrically. By electrically is meant mounting in such a way that the magnetic fields are at right angles, and this can be attained by placing all in the same manner but at an angle, of about 54° to their common center line. Placing them parallel and so that their axes are at right angles to the common center line is inviting trouble.

Correct Angle Can Be Found

It makes no difference whether the axes of the transformers are horizontal or vertical. An inclination can always be found when no more than three transformers are used so that there is not inductive coupling between them, and even so that there is no reactive coupling for one frequency. Reactive coupling includes capacity as well as inductive.

The third source of interstage coupling is the impedance of the B voltage supply. This is a prolific cause of oscillation which is responsible for a large proportion of failures among Super-Heterodynes. The cure is to put a large condenser, about one microfarad, across the portion of the voltage source which feeds the intermediates. That is, it should be connected from the B binding post for these tubes to the negative or grounded side of the filament battery.

When inductive or capacity coupling is at fault, the amplifier oscillates from the beginning or whenever a new B battery is put in the circuit. When the common impedance is at fault the set works well so long as the batteries are fresh, but begins to oscillate so soon as the batteries have developed a considerable internal resistance.

What is the symptom which shows that the intermediate frequency amplifier is oscillating? Prolific squealing when the oscillator condenser is turned. There are squeals of high and low degree all over the dial. It seems that there is not a point which is immune. Of course, good reception is utterly impossible under these conditions. The cure is either to put a by-pass condenser across the B supply or to rebuild the set. A makeshift is to use a rheostat to cut down the filament emission of the intermediate tubes.

Intermediate's Oscillation

Oscillation in the audio frequency amplifier is also quite prevalent. It is nearly always caused by feedback through the common source of plate potential. When it is present the oscillation is a sustained whistle which is not affected to any great extent by operations on the radio or intermediate frequency parts of the circuit. The cure of this trouble is to connect a very large condenser across the voltage source. If the frequency of oscillation is very low, a condenser of moderate capacity and size is quite ineffective. The only thing to use then is an electrolytic condenser of 100 mfd. or more.

Cross-talk between two radio waves is not a defect of the Super-Hetrodyne, but may occur in all other circuits, and can be eliminated by means of tuning, provided that the selectivity is high enough. In the Super-Heterodyne this is not always possible, unless the suppression of the interfering station is done in the radio frequency level before the signal gets to the modulator. The cross-talk which gives rise to most trouble in the Super arises when the frequency of the intermediate filter is just half way, or nearly so, between the two stations. Then the oscillator beats with both of the stations and the beat frequency from both passes through the filter with equal facility.

Squealing is the result. This is a most annoying source of trouble in Super-Heterodynes. Where there are a number

(Concluded on next page)

The Mutual Conductance
As the Figure of Merit of a Vacuum Tube

By Digby Raleigh

WHENEVER the properties of vacuum tubes are given it is customary to give the amplification constant, the internal plate resistance and the mutual conductance. The amplification constant is well known, and this gives the maximum voltage amplification that can be obtained from a tube. In general it gives the number of times that the grid AC input voltage must be multiplied to get the effective AC voltage active in the plate circuit. The internal plate resistance determines the amount of AC that will flow in the unloaded plate circuit when the effective voltage in it is unity. For example, if the internal plate resistance of a tube is 10,000 ohms, the plate AC which will flow when the effective plate alternating voltage is one volt is .0001 ampere. Or again, if the effective voltage is one volt and the plate AC is one milliampere, the internal plate resistance is 1,000 ohms.

But what is the mutual conductance? For one thing it is the constant of the tube which expresses its figure of merit more than either the amplification constant or the internal plate resistance. In fact it combines these two properties of the tube and is the ratio of the amplification of the tube to its internal plate resistance. That is, if u is the amplification constant and r the plate resistance, then the mutual conductance is u/r.

Examples Cited

For example, if the plate resistance is 10,000 ohms and the amplification constant is 8, the mutual conductance is .0008 mhos. The mho is the unit of conductance, and is simply ohm spelled backwards because conductance is the reciprocal of resistance. Since it is preferable to use whole numbers in place of fractions it is customary to express the mutual conductance of tubes in micromhos. Therefore the mutual conductance of the above hypothetical tube is 800 micromhos. This is very near the mutual conductance of a -01A tube.

The mutual conductance determines the plate AC which will flow when the alternating grid voltage is one volt, when there is no load in the plate circuit. Thus in the above case if the alternative voltage in the grid circuit is one volt, the plate current is 800 microamperes, or .8 milliampere.

If there is a load in the plate circuit, the constants differ and they are then referred to as dynamic. Suppose that there is a resistance of 100,000 ohms in the load of the plate. If the steady voltage of the plate battery is adjusted so that the plate resistance remains the same, then the total resistance in the plate circuit is 110,000 ohms, and the dynamic mutual conductance is 8/.11 equals 72.6 micromhas. Then 72.6 microamperes will flow in the plate circuit for every AC volt in the grid circuit.

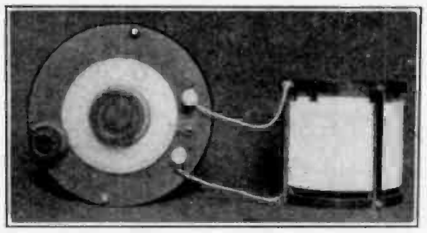
Use of Mutual Conductance

In what way, then, can the mutual conductance be used? Well, if the AC input voltage to the grid is known, the alternating plate current is obtained by multiplying the grid voltage by the mutual conductance. This applies for all values of plate load from zero up, provided that the proper value of conductance is used. If the mu of the tube is 8, the plate resistance 10,000 ohms and the load impedance is also 10,000 ohms ,the mutual conductance under dynamic conditions is 400 micromhos. Then if the amplitude of the grid voltage is 5 volts, the amplitude of the plate current will be 5x400 equals 2,000 microamperes, or 2 milliamperes.

The following table gives the amplification constant (mu), the plate resistance (r), and the mutual conductance (G), for some typical tubes at selected plate voltages E.

Tube	E	r	G	Mu
—99	45	19,500	320	6.25
	90	15,000	415	
—01A	45	18,500	460	8.00
	90	14,000	600	
	135	11,000	775	
—20	135	6,600	500	3.3
—00A	45	30,000	670	20.0
112	157	4,800	1670	8.5
—71	180	2,100	1430	3.0

CUTS INTERFERENCE



(Anderson)

WHEN one station interferes with the reception of another the interference usually can be tuned out with the aid of a simple wave trap such as is shown in this photo. A good variable condenser, preferably calibrated, is connected in series with a low-loss coil of suitable inductance. The secondary coupled to the antenna by the primary and the tuning circuit is then tuned to the interfering wave. A General Radio calibrated condenser and an Aero coil are shown.

Splidorf Licensed; R. C. A. Suit Settled

Continuing with their newly inaugurated policy of granting radio patent rights which they control and are vitally important in producing sets, the Radio Corporation of America recently licensed the Splitdorf Bethlehem Electrical Company. This is the fourth concern to receive such a license, the Zenith Radio Corporation and All-American Radio Corporation, both of Chicago, and the Radio Receptor Company of New York, being the others.

The granting of this license brings to a close the long legal battle between these two companies, which was begun by the R. C. A. in 1926. The R. C. A. claimed that the Splitdorf people infringed upon patents in the manufacture of sets.

Shielding of the Oscillator Is Advocated

(*Concluded from page 6*)

of stations operating at regular intervals apart, and when the intermediate filter happens to be tuned to approximately half the difference, it is impossible to get any of the stations, except two stations that operate at the extreme ends of the wave band. For example, if the stations are separated by 100 kilocycles and if the filter is tuned to 50 kilocycles, it is impossible to receive squeal-free any stations operating on 600, 700, 800, 900 and so on except those that come at the end of the series. That is, if 600 and 900 are the extremes, then these two stations can be received, and at one setting of the oscillator only. If the stations are operated on 550, 650, 750 and so on the situation is just as bad. No Super-Heterodyne has yet been designed which is free from this trouble on account of the broadcasting congestion, and what is more, no Super can be designed to be free from the trouble.

Is there then no relief for the Super-Heterodyne addict? Fortunately there is, and it is not difficult to find. All that is necessary to gain comparative freedom from this annoyance is to make the set selective in the radio frequency level, particularly by the addition of a radio frequency amplifier ahead of the first detector.

Shielding As An Aid

By tuning sharply to the station desired and greatly suppressing the undesired station, the signal from the latter can be made so weak in comparison with the desired one that by the time the interference gets to the modulator it will be inaudible. To make this method effective the oscillator coil and tube should be carefully shielded from the rest of the set and from outside influences so that there will be no direct pick-up. The pick-up coil by means of which the modulator and the oscillator are coupled should be inside the shielded space.

How can the squealing due to cross-talk be distinguished from other types of squealing? Suppose a station operating on 610 kc is tuned in with both the oscillator and the RF tuner. If there is squealing at or near the exact tuning point on the oscillator it is likely that it is due to cross-talk. Suppose now that the oscillator be tuned to the second point at which the 610 station should come in. If the squealing has stopped it was caused by secondary cross-talk. If it has not stopped it probably means that another station is interfering. One station can nearly always be found which is free from squealing at one of the two repeat points of the oscillator, provided the cause is cross-talk.

Use of a Wave Trap

The test can be conducted at a time when one of the stations signs off. If the squealing stops the instant the interfering stations signs off, the trouble is cross-talk. Also if the squealing is caused by cross-talk it can be reduced or eliminated by turning the loop in a direction which cuts out the interfering signal in the radio frequency level. Another way is to employ a wave trap for rejecting the interference. This is quite effective because the two stations are separated at a frequency twice that of the intermediate.

Shielding Must Be Just So

Signals Penetrate One-Inch Hole in "Can"

By Robert F. Gowen

CONGESTION of stations has been responsible for the shielding of radio receivers. Only a year or so ago the broadcast listener could "fish" to his heart's content with the simplest of radio sets and bring in distant stations all over the country without interference. Now the best set that one can buy may have difficulty in the reception of stations over a thousand miles away. The tremendous increase in the number of broadcast stations during the past year demands even better selectivity than can be obtained with present-day equipment.

The average set in New York City has little chance of picking up anything outside of New York, even though the present-day receivers are designed for greatly increased sensitivity. There are very few sets on the market at present that are not sensitive enough to receive the California stations, but who gets the Coast nowadays? The answer is—the really selective set and not the highly sensitive set.

How the Plan Works

As a rule the higher the sensitivity of a set, the worse its selectivity. Adding stages of radio frequency amplification to provide increased sensitivity broadens out the tuning so that, when the signals are delivered to detector tube, there are usually mixed with them signals from other stations operating on nearly the same frequency. This loss in selectivity results from the fact that the radio frequency stages added are usually damped or neutralized in order to prevent oscillation due to interstage feedback of energy from the coupling between the inductances used. Many schemes are used to prevent this feedback without excessive damping. Setting the inductances at what is known as the "sacred angle" to prevent the fields of the coils interlocking is frequently used as well as the addition of a resistance in the grid circuits or a potentiometer control of the grid bias known as a "losser" method.

These methods, when carefully applied to a receiver comprising two stages of radio frequency amplification, produce fairly satisfactory results on either the upper or lower groups of wavelengths in the broadcast band but not on both groups as it is impossible in the usual TRF receiver to neutralize so that absolutely constant or equal efficiency is obtained throughout the whole broadcast spectrum.

A new method of attack has just been presented in the Loftin-White circuit in which the inventors use capacitive as well as inductive coupling between the radio frequency units. It is claimed that this method provides equal efficiency over the complete wavelength band as the one type of coupling balances the other to give a definite sensitivity without oscillation on all wavelengths.

When more than two stages of radio frequency are employed, the problem becomes much more difficult and it becomes necessary to use magnetic shielding to prevent coupling between the inductances of the set and to prevent the loss in selectivity as the sensitivity is increased.

Excellent Results

According to theory, perfect shielding to magnetic fields is impossible, yet proper use of metal shields of certain thickness provides excellent magnetic shielding. Interstage shielding is effective if properly done. On the other hand, if it is not employed strictly in accordance with the best engineering practice, it usually does more harm than good. As a rule the shielding is not complete enough, due, no doubt, to manufacturing difficulties. There are, however, several carefully engineered sets on the market in which the shielding produces very fine results. In some sets, metals of too high resistance have been used as the shielding material or the shielding has been too thin so that its effect for efficiency is practically nil. On the other hand, the manufacturer of these sets gains, perhaps, by the advertising of a shielded receiver. Experience and careful engineering have taught one concern that it is impractical to shield with anything less than thirty mill high conductivity copper.

Although the conductivity of the metal is most important, its value is lost if the shields are not designed properly and completely to enclose the parts affected.

The writer has designed and built Super-Heterodyne receivers, for instance, of such selectivity that if the cover of the completely shielded cabinet is opened only the fraction of an inch, enough energy from high-powered long-wave stations one hundred miles away is picked up by the intermediate frequency transformers to produce an interfering signal in the loud speaker. An experiment is cited where a set containing three stages of radio frequency amplification and tuned to a powerful station fifty miles away was enclosed in a copper case inside of an iron case. The cases enclosed the headset and batteries as well, so that there was no chance for pick-up from the leads. When a one-inch hole was made through both cases, signals were received with great audibility and when the lid of the compound case was raised one-sixteenth of an inch all shielding effect disappeared entirely.

The Vault Experiment

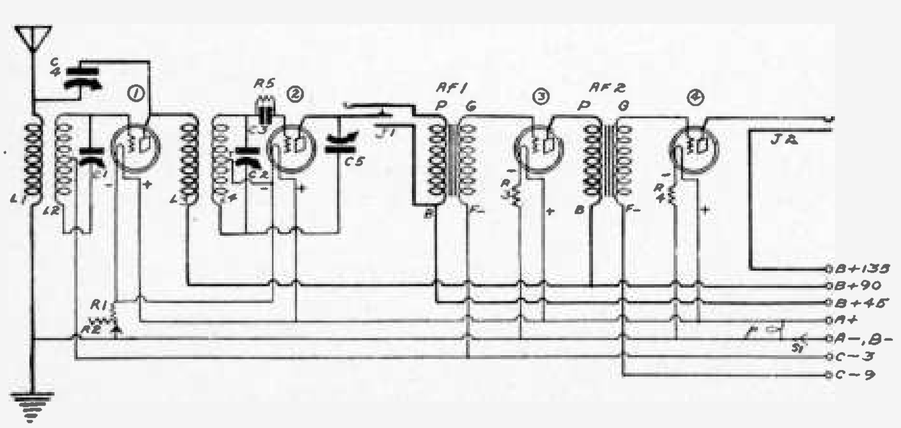
An experiment carried out by the author some years ago showed the effect of shielding in no uncertain terms. A sensitive Super-Heterodyne receiver was taken to the cellar of a bank and placed outside the vault in which location good audible signals were received. The set was then carried slowly into the vault. At a point just sixteen inches inside the threshold of the door, the signals ceased abruptly, showing that the set was surrounded by a perfect shield which the field of the transmitting station could not penetrate.

These experiments and others show that interstage shielding is not enough and that the day is not far distant when all receivers will be enclosed in completely shielded copper cases. Otherwise it will not be possible, with broadcast stations working on super-power, for a set in a congested transmitting area to be affected by the desired station alone. At present, if it were not for the absorption due to the steel buildings in New York City, the field strength of WJZ, WEAF and others would be sufficient to blot out the effect of weaker local stations, if allowed to penetrate the inductances of a set. As the power of broadcast stations is increased the more susceptible to pick-up will be the battery leads, etc. In fact, it is perfectly possible today to get loud speaker reproduction from WEAF, thirty miles away, with a good sensitive four-tube receiver without an aerial. This is an indication that battery leads must be shielded eventually also.

The New Practice

Engineers and manufacturers are now beginning to see that the trend toward the ideal set of the future is to reverse the present practice of building super-sensitive receivers of a great number of tubes, as these receivers require an excessive amount of power supply and maintenance with elaborate shielding to prevent interstage oscillation in the radio frequency stages. The new line of development is to build a simpler receiver, embodying not more than one radio frequency stage of highest efficiency and selectivity in a thoroughly shielded copper cabinet. The Browning-Drake and Hammarlund-Roberts sets are good example of this design. It is safe to assume that eventually the shielded cabinet will include the power unit (or batteries until power units are fully developed) so that there can be no chance of pick-up from cables employed for connection.

BAFFLING CONDENSER ACTION



AN INTERESTING CONDITION that arises in the new Universal receiver, diagrammed above, is that C4, the 50 mmfd. balancing condenser, if set at or near full capacity, will totally prevent reception. At first thought one might suppose the first stage (1) becomes short-circuited, but even so, some signals should come in. A better explanation seems to be that self-oscillation is rendered so strong that nothing can be heard. Of course, with C4 correctly set no trouble whatever arises.

The Design of a Good Set
Traced from the Antenna to the Speaker

DR. JOHN P. MINTON and his associate, I. G. Maloff, addressed the Radio Manufacturers Association on two recent occasions on the subjects of reproduction of speech and music and the design of radio receivers.

Dr. Minton, discussing reproduction, showed how three types and makes of speakers varied in frequency response. One, a horn, had a response range from 450 to 3,000, which was considered entirely too much restricted. Another, an average cone, had a range of from 200 to 3,600, but had many resonant peaks and a marked depression from 250 to 600 cycles. The third, "one of the best cone speakers," had a range from 60 to 6,000 cycles, with very close to constant sound pressure, excepting a peak at about 1,800 cycles.

Speakers Compared

Dr. Minton said:

"The height of this one peak, however, can be reduced without affecting the rest of the curve. This curve is an indication that as far as nearly perfect reproduction is concerned we have been able to accomplish a great deal. This result speaks strongly for the application of scientific methods to development of speakers. It represents results obtained by the replacement of the ear with scientific apparatus, in other words, it makes reproduction a branch of engineering instead a division of psychology.

"How will these three speakers perform on broadcast signals? The horn speaker will reproduce a range from 450 to 3,000 cycles of this curve while the first cone speaker will reproduce the range from 200 to 3,600 cycles. Both these speakers will distort the curve for the pipe organ into something which does not represent an organ at all. The third speaker—one of the best cone speakers—will reproduce this pipe organ music quite accurately and the resultant proportion will be very much superior to that obtained by either of a division of psychology.

Receiver Requirements

Mr. Maloff then spoke. He listed the requirements for a broadcast receiver as follows:

"(1) A high and a uniform sensitivity, which means the ability for long distance reception and also the uniformity of this ability in the whole range of broadcast frequencies (550 to 1,500 kilocycles).

"The high sensitivity is usually obtained by making the radio frequency amplifier of a high voltage gain. However, the audio frequency amplifier is also partly responsible for that.

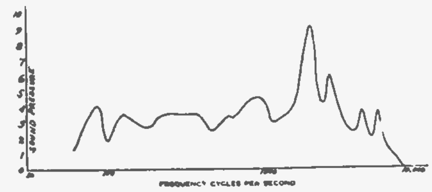
"(2) A high and uniform selectivity, which means the ability of tuning out of powerful local stations, while listening to the weak distant ones. The design details of the radio frequency amplifier and of antenna tuning arrangement are completely responsible for this property. The audio part of the receiver has nothing to do with it.

"(3) High and uniform quality, which property combines fidelity or the truthful response at all audio frequencies and also the freedom from noises."

Efficient Tuning

Mr. Maloff continued:

"The sensitivity and the selectivity go together without any trouble. I mean that it is comparatively easy in a receiver to combine a high selectivity with a high sensitivity, but the quality does not go as well with either of them. The high sensitivity means a very high radio frequency voltage amplification. Noise, static and sometimes the signals from other stations interfere with the reception and ruin the quality.



EXAMPLE of a good cone speaker. The sound pressure is relatively even, except around 1,800 cycle, with a reproduction range from 60 to 6,000 cycles.

"The most efficient radio frequency amplifiers are those using tuned circuits, because by using these circuits the full amplification power of the tubes can be benefited by.

"A tuned circuit is a coil and a condenser in parallel, this coil and condenser so proportioned, that the response of the circuit to a particular frequency is very pronounced. This response drops off rapidly with the impressed frequency increasing or decreasing. It becomes very small for the frequencies distant from the frequency to which the current is tuned.

Three Different Waves

"When the radio frequency wave of a radio station is modulated by an audio frequency wave, the resultant electromagnetic wave is no more of a single frequency or wave length. The analysis of the resultant complex wave shows that this resultant wave consists of three waves having three different frequencies. One wave has the frequency of the original wave (when no modulation was used), the second one is of frequency equal to the original frequency plus the frequency of the modulating wave, and the third one is of the frequency equal to the original frequency minus the frequency of the modulating wave.

"Take a carrier wave of say 1,000 kilocycles (300 meters). If we modulate it with an audio frequency wave of 5,000 cycles, we get a complex wave of three frequencies namely 995, 1,000 and 1,005 kilocycles. Under ideal conditions a receiving set should let these three frequencies go through equally amplified in magnitude.

Too Sharp Tuning

"Dr. Minton has just explained to you that for a sufficiently faithful reproduction of speech and music a uniform response to all audio frequencies from 75 to 5,000 cycles is necessary. Now if the resonance or tuning of our radio frequency amplifier is too sharp the higher audio frequencies will not go through it, because the circuit will have very little response to: first, the frequency of the carrier plus the frequency of modulation; and second, the frequency of the carrier minus the frequency of modulation. The latter two frequencies are often called the side bands. This means that the resonance peak of a radio frequency amplifier must be at least 10 kc wide at the top for good reproduction, and at the same time it means that broadcasting stations must be spaced at least at 10 kc apart to prevent interference.

"The radio receivers differ one from another chiefly in the principle on which their radio frequency amplifying systems are built.

"By radio frequency amplification I mean the ratio of RF voltage which the set delivers to the grid of its detector tube, to the RF voltage induced by the electromagnetic waves in the antenna or its substitute.

Detector's Function

"The function of the detector is to separate the modulated carrier wave from the wave of modulation and deliver it to the audio frequency amplifier. The detector itself can introduce only a very little of frequency distortion, but when overloaded it distorts the wave itself, causing mushy and very unpleasant reception. However, if the audio frequency amplifier is able to give a sufficient gain, there is no need of overloading the detector.

"For some unknown reason the importance of adequate audio amplifier was overlooked by many manufacturers. Many sets on the market have very good RF circuits, but very few of them have the audio circuits of the same grade.

"The audio frequency stages usually utilize one of the three kinds of coupling; transformer, impedance, or resistance.

Likes All Three

"An amplifier can be made just as good by using one as well as another of these three types of coupling. The trouble is however that often too much or too little is required from them. For instance there is a receiver on the market utilizing resistance method of interstage coupling.

"The designer tried to get the highest gain obtainable and placed resistances of one-half megohm as couplings. In order to get high response at low frequencies he used condensers of very high capacities and as a result his set is subject to flutter, or as it is often called, motorboating when used with battery eliminators and lacks in high frequency response on account of the grid circuit of the following tube shunting this coupling resistance.

"In another commercial set the transformer type of coupling is used, the transformers being of high ratio and insufficient primary impedance. This set is very quiet even with the worst kind of battery eliminator, but responded only to the frequencies in the middle range, which means lack of depth and lack of brilliancy of the reproduced sound.

Easily Corrected

"In the latter case the trouble can be easily corrected by using a high grade of iron as the core material for the transformers. Nickel-iron alloy or copper-nickel-iron alloy usually saves the situation. In the case of resistance coupling a complete redesign is usually necessary.

"So you see there is quite a number of various factors involved in the performance of a receiver. The designer of a radio set must take all of them into consideration, analyze everyone of them and step by step work out the complete receiver. However the slide-rule alone is not sufficient, one must be able to check his calculations. Many designers have to depend on their ear for this check. They put receiver together and try it out. If it sounds not as expected, they make a few changes and try it again. If they are lucky they get good results, if not, they put out sets that are unsatisfactory.

Needs Laboratory Test

"Another important point against them is that these people test their sets under a particular set of conditions and must guess the rest."

The Plate Resistance
As a Factor In Efficiency of Tubes

By Babson Rutgers

IN discussing the theory of tubes and of amplifiers the terms plate resistance, internal plate resistance and output resistance of the tube are quite frequently employed. They mean the same thing, but just what do they mean and of what use is a knowledge of their values for a given tube?

The internal plate resistance is the reciprocal of the slope of the plate current plate voltage characteristic. Let us illustrate with a drawing. Referring to Fig. 1 let the plate current be represented by the curve. When the voltage applied to the plate is OA, the current is AB. At the point B the curve has a certain slope which is the slope of the tangent line CD, which touches the curve at the point B. The slope of this line is the ratio AB/CA. The reciprocal of this ratio is CA/AB, which is the plate resistance.

However, it is not customary to define the slope in this manner. Instead it is done in the following manner. The voltage on the plate is reduced from A to B, giving a current EC'. Then it is increased from A to E', giving a current E' C". The decrease AE is made equal to the increase AE'. The difference between EC' and E'C" is GC". The slope is then GC"/GC".

Depends on Applied Voltage

When AE and AE' are very small this slope is the same as AB/AC, and it is called the slope of the curve at the point B. The plate resistance is equal to GC'/GC", provided that E and E' are very close to A. This defines the alternating current resistance at the point B, and that is the resistance which must be considered when dealing with amplification and oscillation.

It will be observed that the slope of the curve, and therefore the resistance of the tube, depends on the plate voltage applied. The slope increases as the voltage increases and therefore the resistance decreases as the voltage of the plate increases. This decrease in the resistance keeps up until the current saturation is approached, that is until the curvature bends in the opposite direction.

The direct current resistance of the tube is different from the alternating current resistance. It is measured at the point B by the ratio OA/AB. It is this resistance which determines the total flow of direct current in the plate circuit for any given plate voltage. This also varies with the voltage. About the only use of the DC resistance is to determine the effective plate voltage when there is a resistance in the load circuit of the tube.

The plate resistance also depends on

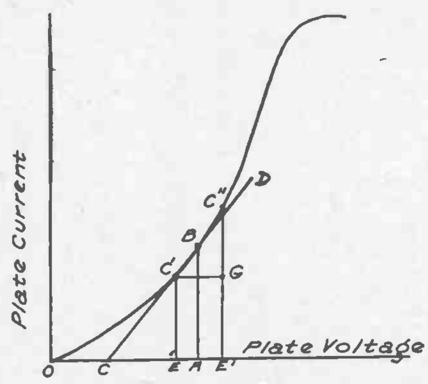


FIG. 1

Curve showing the relation between the plate voltage and the plate current in a vacuum tube. The reciprocal of the slope of this curve at any point B is the plate AC resistance. Thus in the curve the resistance is GC'/GC", when E and E' are taken very close to the point A.

the filament temperature of the tube. The higher the temperature of the filament the greater will be the current flowing for any given plate voltage, and hence the lower is the plate resistance. This lowering is particularly large for the higher plate voltages because the tube will rise much higher before the saturation is reached.

Effect of Bias

The grid bias voltage also has an influence on the value of the plate resistance at any given plate voltage. Hence it is necessary to specify the grid voltage when giving the plate resistance of tubes. It is customary to give the plate resistance at zero grid bias. Sometimes, however, it is given at the bias where the tube is supposed to work at a given plate voltage. This method is the more valuable since we are always interested in the plate resistance under working conditions. The plate resistance increases as the negative grid bias is increased.

When matching a transformer primary to the plate resistance of a tube, the AC resistance at the plate and grid voltages used is employed. For maximum power output the impedance of the transformer primary should be equal to the resistance. For the maximum undistorted power output of the tube the load impedance should be twice the resistance of the tube. When the tube is used as a voltage amplifier, as in resistance and impedance coupled circuits, the load resistance or impedance should be very large in comparison with the plate resistance of the tube, to get the greatest step-up. When it is a question of least distortion the load impedance or resistance should also be as large in comparison with the tube resistance.

Matched Impedances

It has been stated repeatedly that the impedances of the tube and of the primary of a transformer should be matched for greatest step-up of voltage in this type of coupling. That is not so. Maximum power is not maximum voltage. To get the greatest step-up in the voltage the primary impedance should be large in comparison with the resistance of the tube, that is, if the ratio of the transformer is constant.

The plate resistance of the tube has a considerable effect on the motorboating tendency of a circuit, particularly the resistance of the plate of the last tube. If the circuit oscillates at a low frequency, the pitch of the oscillation will be decreased as the plate resistance of the last tube is reduced, provided that other conditions remain constant. The resistance can be reduced without altering other conditions by putting two or more similar tubes in parallel at the output. Suppose the circuit oscillates at a low frequency when one tube is used. When two tubes are used in parallel the frequency will be lower and the oscillation less intense. When three tubes are used the oscillation will be of still lower pitch and intensity, or it may be absent entirely. If it is, the frequency of the oscillation has been reduced to zero, as has the intensity.

One reason why the oscillation stops in this manner is that the frequency of probable oscillation is decreased by decreasing the plate resistance, and if this is low enough there will be no amplification at that frequency because the stopping condensers in the circuit block the interfering signal. Amplification is a prime requirement for oscillation at any frequency.

Examples Cited

The plate internal resistance of a —71 tube at 180 volts on the plate and 40 volts negative grid bias is 2,100 ohms. When two of these tubes are connected in parallel the effective output resistance becomes 1,050 ohms when three of them are connected in parallel the output resistance is 700 ohms.

If the plate voltage is only 135 volts and the grid voltage is 27 the output resistance is 2,200 ohms for one tube.

The following list gives the plate resistances for popular types of tubes for various voltages:

Tube	Plate V.	Grid V.	Plate R.
—99	45	1.5	19,500
	67.5	3.0	16,500
	90	4.5	15,000
—20	90	16.5	7,700
	135	22.5	6,600
—01A	45	1.5	18,500
	90	4.5	12,000
	135	9.0	11,000
—112	157	10.5	4,800
—71	90	16.0	2,500
	135	27.0	2,200
	157	33.0	2,15C
	180	40.0	2,100
—10	350	27.0	5,100
	425	35.0	5,000

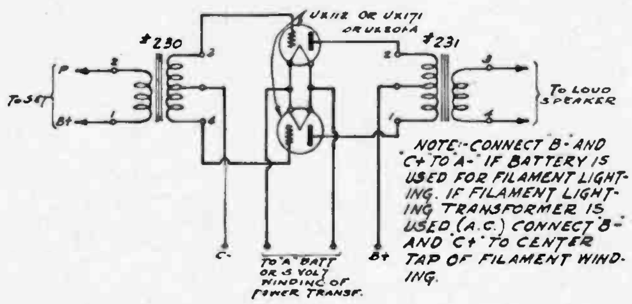
Laboratories Replacing Ear In Test of Receivers

RF and AF Oscillators Used in Determining Selectivity And Sensitivity

Manufacturers and designers are resorting to laboratories to replace their ears in the task of development of receiving sets. In order to be able to tell how good or bad a receiver or its component part is, the following equipment is necessary; a radio frequency oscillator covering the whole range of broadcast frequencies; an audio frequency oscilator covering the whole range of audible frequencies; arrangements for modulating the RF oscillator by audio frequencies; devices for measurements of output and input signals and sound.

Push-Pull for Last Stage
Advocated for Tone and Power Handling

By Mc Murdo Silver



POWER AMPLIFIER of the push-pull variety, constituting the audio output stage of a receiver.

WITH the insistent demand that the sounds emanating from the average radio loudspeaker be substantially an accurate reproduction of the original program—that the "tin can" reproduction of several years ago be done away with—developments leading toward better reception have followed several courses: improvement of transmitting equipment, receiving amplifiers, and speakers.

Since the average home experimenter has no control over broadcast stations or speaker designers, the part he has played in the advancement of radio reproduction has lain almost entirely in the field of receiving amplifiers, while the bigger broadcasters have gradually brought their program transmission to an indeed remarkably high level, at the same time that speaker makers have done quite a sizeable bit in the development of rather excellent speakers.

But this development and improvement work is far from ended—quality of reproduction has not as yet attained the generally high level which it will reach in time—and toward which another tremendous stride will be taken during the next radio season.

The Next Step

And this next advancement is to be made by fans—the step that will bring their receivers up to a level where the excellent broadcast programs and the capabilities of the finer loudspeakers will not be wasted by the lack of perfection of the average fan's receiver.

Developments in audio amplifiying equipment have of late followed two channels—the production of suitable power tubes, and the development of audio coupling devices, for use between these tubes, of non-discriminating frequency characteristics. This course, traced over several years, is interesting, advancing as it does, step by step with the perfection of broadcast transmission and loud speaker design.

Audio amplifiers originally were intended for telegraph reception, and maximum amplification was desirable at about 1,000 to 2,000 cycles. Such amplifiers as existed when broadcasting came into popularity, having desirable telegraph reception characteristics, were totally unsuited to broadcast reception where a frequency band of 30 to 5,000 cycles had to be passed for faithful reproduction. Audio transformers were responsible for the 1,000 to 2,000 cycle hump in all of the older amplifiers, so attention was first given to flattening out their characteristic curves sufficiently to cover the desired frequency range. While this work was going on, resistance coupled audio amplifiers were revived solely because they afforded flatter frequency characteristics than did the existing transformer amplifiers. As an offshoot came impedance coupling—a compromise between resistance and transformer coupling, possessing certain disadvantages of both methods without attaining fully the advantages of either.

Frequency Range Extended

The net result of amplifier improvement was an extension of the frequency range, first upward, then gradually down to 200 cycles, then to 100, and, finally, all the way down to 30 cycles. As each step in the downward extension of operative frequency range was made, the *power* which has to be handled by the amplifier tubes increased by leaps and bounds. For a given audible response at 2,000 cycles, only a given amount of energy is necessary; about 8.75 times this energy is necessary to produce the *same* apparent sound sensation at 256 cycles. Going down further, to 128 cycles, about 17.5 times the energy is required while at 64 cycles, 175 times as much energy is necessary. Finally, with the best amplifiers of today functioning down to 30 cycles, we find that the energy ratio to be encountered in reproducing the frequency range of 30 to 5,000 cycles will be on the order of 2,000 times. Briefly, an amplifier tube in a good modern amplifier of today is called upon to handle at least 2,000 times as much energy to give faithful reproduction as was the old original telegraph audio amplifier working at 1,000 to 2,000 cycles!

With the realization of this fact, power tube were developed for audio amplification, first the —01A, in its day a "power" tube; next the 112, and then the 310 and 210 type. As the 310 and 210 tube required high operating voltages, a compromise tube was developed—the 371 and 171—requiring a not abnormal plate voltage. The —71, with 180 volts plate potential, had more than half the power capacity of a 210 with 400 to 450 volts plate potential; so two 170s in parallel, requiring a low operating voltage, were preferable to one 210 tube from a practical operating standpoint.

Handling of Power

Then, as the power handling capacity of resistance amplifiers was found to be insufficient for high quality low note reproduction, because of the voltage waste inherent in resistance amplifiers, transformers came back into popularity as types were developed with flat frequency characteristics down to 30 cycles, and because of their far greater efficiency. At the same time, a gradual public appreciation of facts demonstrated years ago in the Bell Telephone Laboratories began to appear, and transformer amplifiers were developed providing amplification only over the desirable range of 30 to 5,000 cycles. Transformers were more applicable to a realization of such characteristics, since certain inherent design features could be taken advantage of which were absent in resistance systems—hence a modern transformer amplifier is freer from static, heterodyne squeals, and parasitic noises than resistance coupled amplifiers, besides having far greater handling capacity together with the absence of power waste encountered in resistance systems.

But of late another realization has thrust itself in upon the fan—a condition faced and provided for years ago in telephone practice. This has to do with the fact that no single power amplifier tube available today is capable of providing the power required for ordinary home reception without serious distortion.

A Sensible Trend

It is well known that 201A and 112 type tubes are totally inadequate for last audio stage use in a *good* amplifier, and fans are fast realizing that 171 and 210 tubes are inadequate, too. Even the high voltage 210 power packs introduce distortion apparent to the ear (when compared against a better system) on normal home volumes, as any advanced experimenter or engineer knows.

The trend seems to be quite a sensible one at present—not to the extreme typified by high voltage, 210 power packs and a cry for bigger tubes—but toward an intelligent utilization of the capabilities of existing power tubes to the fullest extent. To realize that present popular amplifying systems do not obtain even half maximum value from existing tubes, it is only necessary to consider the possibilities of push-pull amplification—possibilities that allow two 112 tubes, operated upon 180 volts or even less, to handle more energy than a 210 tube at 400 volts or more. Two 171s in a push-pull circuit will provide a greater undistorted power output by several times than a 210 tube.

Push-pull amplification is not new. It has been known and used for years in the few cases where its full value has been appreciated. When originally available to fans, however, it was of little value with old tubes and transformers, and with the quality of broadcast transmission and speakers current four or five years ago.

New Appreciation

The power handling requirements of old audio amplifiers, seldom operating below 200 cycles, were not great, so that push-pull was little appreciated several years ago, and only gained real recognition with the general realization of the need of reproducing low frequencies to render reception natural. As a result, an almost ideal amplifying system, years in advance of equipment available, was discarded for lack of appreciation of its full worth. It is only today, with the advent of modern flat-characteristic coupling transformers, that it again comes into its own as the logical means of handling, without distortion, the power necessary for home reproduction.

The theory of push-pull amplification is quite involved, but a good idea of practical operation may easily be obtained. In an ordinary audio amplifier, overloading takes place when the signal voltage applied to the tube's grid becomes so great as to run beyond the straight portion of the plate current-grid voltage curve. When this occurs, due to the curvature of the ends of the curve, harmonics, not in the original applied signal, are generated and appear in the output circuit. Obviously, such harmonic generation introduces distortion, so that the tube must be limited in power output to input voltage excursions of a value insufficient to run beyond the straight portion of the plate current—grid voltage curve.

Grids Oppositely Phased

In a push-pull amplifier two tubes are fed from the same transformer so that as the grid of one becomes positive due to applied signal voltage, the grid of the other becomes negative. Thus, with an input vol-

(*Concluded on page 20*)

Studio Lights and Scenes Devised to Inspire Artists

Spotlight for Operatic Singers, With Microphone Invisible, and a Roman Forum for Prominent Men Schemed Out by N. B. C.

By J. T. W. Martin

Psychological stimulation of broadcasters' performers by means of lights and decoration will be attempted on a more elaborate scale than ever before in the system of studios which has been planned for the new National Broadcasting Company Building now being erected at 711 Fifth Avenue, New York City. Specifications have been drawn for eight separate studios, six of which will be decorated and lighted to provide mental stimulus for different types of broadcasters.

According to present plans, operatic and stage stars will face the microphone in a large studio, with a spotlight playing upon them. The rest of the room will be dimly lighted, with the microphone placed in shadow where the artist can not discern it, and the vista which will open before the performer will present the effect of a large auditorium, with a silent audience waiting to applaud the broadcaster's efforts.

Other studios will provide conditions under which public speakers, jazz orchestras, religious leaders, vaudeville performers, symphony orchestras and other individuals and groups should be able to put forth their best efforts when broadcasting, because they will be working under stimuli which register strongly upon their particular sensibilities.

The studios have been laid out by engineers of the National Broadcasting Company under the supervision of O. B. Hanson, manager of operations and engineering, working in cooperation with Raymond Hood, architect of the new building.

Responds to Observing Eye

When Mr. Hood first visited a broadcasting studio, he was impressed by the drabness of the surroundings. A famous tenor was on the air, and it was the architect's opinion that the vocalist could not do his best under the conditions which surrounded him. After the broadcast. Mr. Hood talked with the tenor, whom he had known for a long time, and the singer's remarks seemed to confirm the architect's suspicions. Instead of lifting the emotions of the artist and inspiring him to put forth his best effects, the surroundings tended to dispirit him.

Mr. Hood had observed many actors and singers backstage, waiting for their entrance cues, and he knew the nervousness which pervades even the most experienced artists at this time. He had watched them and noticed the disappearance of all nervous tension as soon as they stepped on the stage and came under the influence of the lights, the dim auditorium and the silent, waiting audience. He knew that the reactions of actors and singers had been considered of foremost importance in the N.B.C. development of many stage lighting effects of the present day, and it appeared to him that work along the same lines could be used to stimulate broadcast performers to extend their artistic powers.

In addition to the large roof described above, known as Studio B, there will be four other studios on the same floor. Two of them, like Studio B, will be two stories in height, while two others will be only one story high. The same floor will also contain reception rooms, smoking rooms and coat rooms for the artists and one large room occupied by the operations and engineering department. On the floor above will be two more of the smaller studios and the battery and generator equipment. The second floor above will contain an auditorium which will also be equipped so that it can be used as a studio.

Forum for Prominent Men

One studio has been designed to appeal to prominent men. The suggested effect is that of the Roman Forum. Columns appear in the background, and a scheme of Pompeian decoration will be produced by hidden lights. Another studio is designed to stimulate minds to which the mystic carries a great appeal. Here the impression will be that of a Gothic church, with alternate light and dark sections suggesting the arch and aisles of such an edifice. From a concealed point near the ceiling, the pattern of a church window will be thrown on the floor in light.

Performers who are stimulated by ornate decoration should react strongly to a third studio in which the general scheme suggests the decoration of the time of Louis XIV. Gilt and pastel colors will be much in evidence and through a window, the effect of looking into an elaborate garden will be produced.

Two of the four smaller studios will be left unadorned, for the use of experienced broadcasters who react strongly to the mere presence of the microphone and the knowledge that millions of radio listeners are hearing them, although the audience is an invisible one. The success of the decoration schemes of the other studios will determine whether or not similar effects will be used in these two rooms.

One of the smaller studios will be elaborately decorated to stimulaté jazz performers. In this room, the decoration scheme will be wildly futuristic, with plenty of color in bizarre designs. The last of the studios has been designed to appeal to serious minds. The general effect in this case will be that of a fine library.

Unique In Layout

The auditorium, seating approximately 200 people, will be provided with lighting arrangements which will allow several different effects to be obtained when the room is to be used for broadcasting.

The special lighting effects which will be utilized to provide the desired stimulation in the various studios are being worked out in detail by M. Luckiush, of the Lighting Research Laboratory, of Nela Park. Cleveland, Ohio, an expert in stage lighting.

Aside from the decorative effects, the eight studios will be unique in their layout.

TUBE PACIFIER

(Hayden)

IF YOUR tube howls—particularly the detector—due to a critical hookup, try putting some sealing wax on the tube.

Reception Conditions Soon to be Forecast

Washington.

Relationship between radio atmospheric disturbances and solar activities seems to be closer than between solar activities and magnetic storms. This is the latest discovery of Dr. L. W. Austin, of the Bureau of Standards Radio Laboratory, who is considered to be an authority on atmospheric disturbances.

Dr. Austin believes it is only a question of time before the scientist definitely gets at the root of the cause of static. When that occurs, says he, it will be possible to have something real upon which to base efforts to prevent static from interfering with broadcast reception.

It may also be possible, Dr. Austin thinks, to determine ahead of time how reception will be for any given period once the connection between radio atmospherics and solar activities are definitely established.

"There are three active regions of the sun which we suspect have an effect on radio reception," says Dr. Austin. "There is the eleven-year period of sun spots' increase and decrease. There is the twenty-seven day period of the sun rotation. Radio phenomena seem to follow that period of rotation. Then there is also a shorter period of nine days which seems to be prominent.

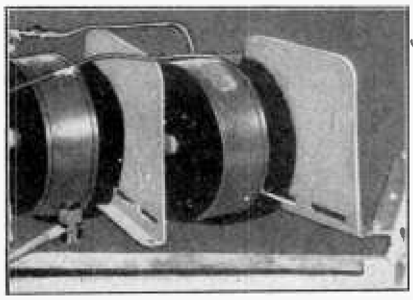
"It appears to me that the things that affect radio reception are some deeper phenomena which themselves cause sunspots. Radio is giving us a new method of studying the sun's condition and undoubtedly we will obtain some very valuable information and data from observations which are now progressing."

Radio Saves Life As Gas Is Escaping

Los Angeles.

Radio has saved another life. A man was listening in and, getting drowsy, fell asleep by the receiving set. The gas stove was on and all of the windows were closed. This person was aroused next morning early by the setting-up exercises in a very feeble condition. Carbon monoxide gas was working and it was all the radio fan could do to crawl to a window, break it and cry for help.

NEAT SHIELDS



(Hayden)
ALUMINUM shielding is favored to prevent harmful interstage coupling. The American Radio Hardware Co. shields are shown.

Patent Snarl Rises In Australia, Too

The Amalgamated Wireless (Australia), Ltd., has created widespread attention among the wireless traders and users in Australia, by announcing that it owns certain radio patents and its intention of collecting royalties on every tube receiving set sold.

The corporation, in which the Federal Government has a controlling interest, contends that it holds the Australian patent rights of 145 Marconi radio patents. No tube receiving set, it claims, can be built or imported without utilizing one or more of these patents.

If the company can prove its rights to the patents, the price of wireless sets will be greatly increased. Australian radio traders are doubtful whether Amalgamated Wireless holds the patents it claims, and have organized a company, the Victorian Radio Interests Pty. Ltd., to oppose the efforts of the Amalgamated Wireless.

As so many patents are involved in the company's claim, an average fee, based on the number of tubes in a set, has been fixed. For each English tube in a set, the company demands payments of 12s. 6d. royalty (about $3.), and for each American tube 17s. 6d. American tubes are used in most instances.

The company claims that it holds patent rights on regeneration, grid leaks and tubes.

U. S. to Australia and Back in 5 Minutes

Four members of the Australian Industrial Commission visiting Schenectady made brief addresses over 2XAF, the General Electric Experimental station, which operates on a wavelength of 32.79 meters. Their addresses began at 5:30 A.M. and ended at 5:48.

At 5:53 an American amateur wireless operator, William Jackson, picked up at his station, 2AHM, a test message from W. T. Watkins, an amateur operating station 7DX, at Hobart, Tasmania, saying that the entire 2XAF program had been received.

"It was fine business, loud and clear. Could even hear the microphone rustle," the message declared.

FADA LOSES SUIT

Word was received by the Radio Corporation of America that the Canadian General Electric Company has won its suit on the Alexanderson tuned radio frequency patent in Canada. The apparatus involved in the suit was a Fada Neutrodyne receiver. Alexanderson licenses under the Canadian patent have been granted to Canadian Westinghouse Company and other Canadian concerns.

Check on Transmitters Withdrawn by Portland

Action Follows Suit by Relay League, Which Maintained Cities Have No Authority Over Federally-Licensed Stations

PORTLAND, Ore.

That a municipality has no authority to regulate Federally-licensed radio stations and that municipal radio-interference ordinances cannot be held applicable to them was admitted by the City Council of Portland recently when it amended the Portland ordinance to exclude such stations from its provisions. The action of the council, which is regarded as extremely significant in determining the attitude of municipalities elsewhere, came as a result of an attack on the measure in the Federal Court by the American Radio Relay League, the national organization of radio-telegraphing amateurs, through its general counsel, Paul M. Segal, of Denver, Colorado.

Although by revising the ordinance the city has refused to permit its legislation to be made the basis for a test suit involving the rights of a municipality to regulate Federally-licensed radio transmitters, League officials regard the move as most important in establishing the rights of such stations.

Under the terms of the Portland ordinance, which was drawn up to suppress and regulate interference of all kinds to broadcast receiving sets in operation in the city, practically all types of high-frequency generating systems were subject to licensing, taxation and control.

Objects for 19,000

Apparatus so covered included violet-ray and X-ray machines and broadcast and amateur radio stations. The suit instituted by Mr. Segal on behalf of the 19,000 amateurs comprising the American Radio Relay League sought to enjoin the enforcement of the ordinance as it applied to amateur and other Federally-licensed radio transmitters.

In seeking the injunction, Mr Segal pointed out that the ordinance was unconstitutional in that it sought to control and regulate interstate commerce, power which is vested solely in the Federal Government that the ordinance did not and could not establish a basis on which to judge a station for interference and that the measure at times was in direct violation of the provisions of the license issued the amateur by the Government. It was pointed out that in all instances where such conflict occurs the Federal provisions supersede local regulations.

On learning of the suit the city authorities immediately drew up an amendment pertaining to broadcast commercial and amateur stations in order that the ordinance as a whole might not be endangered. The amendment as passed provides that the terms of the ordinance shall not apply to radio stations, either broadcast, commercial or amateur, which are licensed by the government.

What Other Cities Held

This amendment reduces the ordinance to a simple police measure designed to prevent the operation of static and X-ray machines during the hours of broadcast reception.

The situation brought out in the suit by the League is one which has been carefully studied by other municipalities for some time. The city of Atchison, Kansas, in 1923, drew up an interference ordinance, but upon opinion of the city attorney that municipal regulation of amateur communication was illegal, the measure was drawn up so as not to apply to such installations. A similar opinion has been rendered by the city attorney of Minneapolis with respect to an interference-prevention ordinance in that city, it being held that no such ordinance is applicable to stations licensed by Federal authority and operated under the terms of such licenses.

In view of these decisions, other cities will be slow in adopting ordinances seeking to regulate licensed stations, in the opinion of the League's counsel. Mr. Segal, himself an amateur of Denver, is one of the directors of the League, representing its Rocky Mountain Division, and is by profession the prosecutor at Denver's West Side Court. His hobby, however, is radio law.

Airway Beacon's Pass Commerce Dept. Tests

Satisfaction with tests made with the radio airway beacon being perfected by the Bureau of Standards for the Aeronautics Branch of the Department of Commerce was expressed by William P. McCracken, Jr., Secretary of Commerce for Aeronautics. Mr. McCracken had inspected the beacon and radio markers at College Park, Md., where two-way communication between the Department of Commerce plane in which he was flying and the ground station was maintained.

"The beacon performed very satisfactorily," said Mr. McCracken, "but a few minor changes will have to be made before the beacons are ready to be constructed in quantities for use on the civil airways. As soon as the device is ready, the airway division of the Department of Commerce will proceed with its installation along the airways, using its extension superintendents for the work."

New Radio Burglar Faces Death on Sight

Employing the same tactics as Paul Hilton, the "radio burglar" who was executed a short while ago at Sing Sing, a marauder has been burglarizing the homes of Jamaica, N. Y. residents. The thief steals the radio set and then smashes the batteries, this being the same method used by Hilton. Just why the batteries are broken is a mystery. The police issued a warning that they will shoot to kill if they sense in any way a battle with this robber. They are taking these steps because Hilton killed a patrolman and severely injured another.

MARKHAM AT KHJ

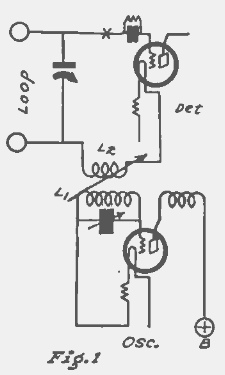
Los Angeles.

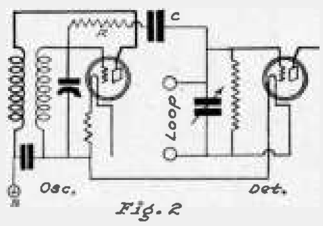
Among the distinguished visitors of the month at KHJ in Los Angeles was Edwin Markham, eminent poet, who delivered some of his own readings, including his verses.

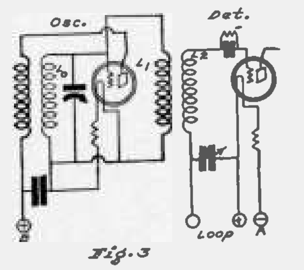
Five Different Pick-ups
Of Oscillators in Super-Heterodynes

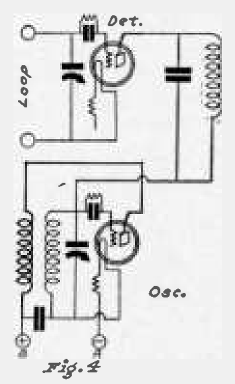
By J. E. Anderson

Contributing Editor; Consulting Engineer; Associate, Institute of Radio Engineers









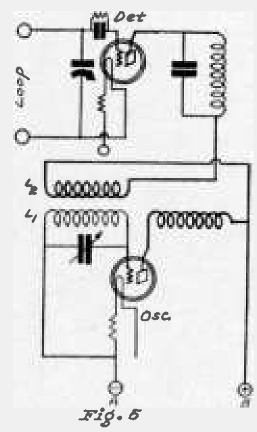


FIG. 1—A common type of pick-up of the oscillations in a Super-Hetrodyne. The pick-up coil L2 is connected in the grid return lead of the modulator and coupled loosely to the oscillator coil L1. This has the disadvantage of preventing grounding of the loop tuning condenser. A slightly better arrangement is to connect L2 at the point marked X.

FIG. 2.—A type of resistance capacity pick-up in which the grids of the modulatior and the oscillator tubes are connected by means of a high resistance R and a condenser C. Both tuning condensers can be grounded to eliminate body capacity effects, and there is no danger of getting the coupling between the two tuned circuits too close.

FIG. 3.—A type of pick-up in which the coil L1 is connected in parallel with the oscillator coil and then coupled inductively to a small coil L2 in the grid lead of the modulator. It permits grounding of both tuning condensers for a minimum of body capacity effects. L0 and L1 must be larger than for other connections.

FIG. 4.—In this pick-up no plate potential is used on the modulator except that afforded by the filament battery.

FIG. 5.—This illustrates another type of plate pick-up. A regular plate voltage is used on the modulator but this is varied by the oscillations introduced by means of L2 which is coupled to the oscillator coil. The advantages of this type of coupling are that both tuning condensers may be grounded and the coupling between the tuned circuits can be kept down to a minimum without reducing the pick-up.

THERE are many types of pick-up used between the oscillator and the first detector in Super-Heterodynes to produce the same result. If the coupling between the two tubes in each case is equal, the results are exactly the same as far as the production of an intermediate frequency is concerned, but all do not show the same interaction between the two tuned circuits nor the same body capacity effects.

It is always desirable to keep the interaction between the two tuned circuits as low as possible, otherwise the operation of the Super-Heterodyne will be erratic and sometimes the circuit will not work at all. The body capacity effects must also be kept at the lowest value possible. This applies both to the detector tuner and the oscillator.

In Fig. 1 is shown a case of inductive coupling between the oscillating coil and the grid circuit of the detector. This is a common method and is satisfactory. The amount of coupling or pick-up can easily be varied by turning the small coil L2 with respect to coil L1. The rotor plates of the oscillating condenser are connected to the negative A. This effectively eliminates body capacity effects at the oscillator where their absence is most important.

Connection of Pickup

The pick-up coil L2 is connected on the low potential side of the loop tuner in the present case. That seems to be a very popular method of coupling, although it is theoretically better to insert the pick-up coil in the high potential side of the loop, or at the point marked X in Fig. 1. One reason for placing it so often in the lower position is that it simplifies the drawing of the circuit. When it is placed in the lower position as in Fig. 1 the body capacity effects on the loop tuner are slightly greater than when the pick-up coil is placed at the point X. When L2 intervenes between the A battery and the low side of the tuner, that side (rotor plates) cannot be grounded, and consequently it is always at a higher potential than the hand that tunes. Hence body capacity comes into play. It is not serious, however, except for the shorter wavelengths in the tuning band.

The amount of pick-up from the oscillator depends on the coupling between L1 and L2, that is, on the number of turns in the coil L2, on its diameter, and on its distance from L1 and on the angle it makes with the oscillator coil. The closer the coupling between the two coils the louder will be the signals. As the coupling is increased between the two coils the interaction between the two tuned circuits increases and they will not tune independently of each other.

Cause of No Signals

There is one critical coupling above which the oscillator will not oscillate. No signals can then be received. Sometimes it will continue to oscillate, but at the frequency of the signal to be received. Then no signal will come through. The failure from either of these causes is usually accompanied by a click or a thud. This trouble is due to too close coupling, as has been stated, between the pick-up coil and the oscillator, or rather between the loop and the oscillator. This trouble is especially annoying when the intermediate frequency used is low, say between 40,000 and 20,000 cycles.

A second method of coupling oscillator and detector is shown in Fig. 2. The grids of the two tubes are connected together through a high resistance R and a condenser C. The resistance should be about one megohm and the condenser capacity about .0001 mfd. This method has many advantages. It permits grounding of both the tuned circuits, thereby eliminating all troublesome body capacity effects when tuning. It also prevents too close coupling between the two circuits, thereby insuring independent action of the two. The tuning of the loop will not stop oscillation in the oscillator nor change its frequency. Since the resistance is very high the coupling remains the same for all frequencies, the condenser having small effect in throttling the current.

A Special Coupling

In Fig. 3 is shown a type of coupling which has been advocated recently. It is a special form of that shown in Fig. 1 in that the oscillator is coupled to a small coil in series with the grid circuit of the detector, or at the point X in the first figure. The pick-up coil L2 is not coupled directly to the oscillating coil LO, but to a coil L2 connected in parallel with it. This method has the advantage that both tuned circuits can be grounded so that body capacity effects can be minimized. However, the two windings LO and L1 are in parallel. This makes it necessary to increase the inductance of both the coils so that the inductance of the parallel combination is enough to cover the tuning range properly. If the two are equal each must be made just twice as large as if LO alone were used.

The three coupling methods discussed above introduce oscillations in the grid circuit of the detector. A voltage thus introduced has a very much greater effect than the same voltage introduced into the plate circuit of the detector. In fact, if the amplification factor of the detector tube is 8, the effect of a given voltage is just eight times as great when introduced in the grid circuit as when it is introduced in the plate. This fact makes it possible to use a looser coupling between oscillator and detector to get a certain result, and thus interaction between the two tuned circuits can be kept down.

Plate Modulation

Fig. 4 shows a case in which the ocsillations are introduced into the plate circuit

(Continued on next page)

Power Sent By Radio

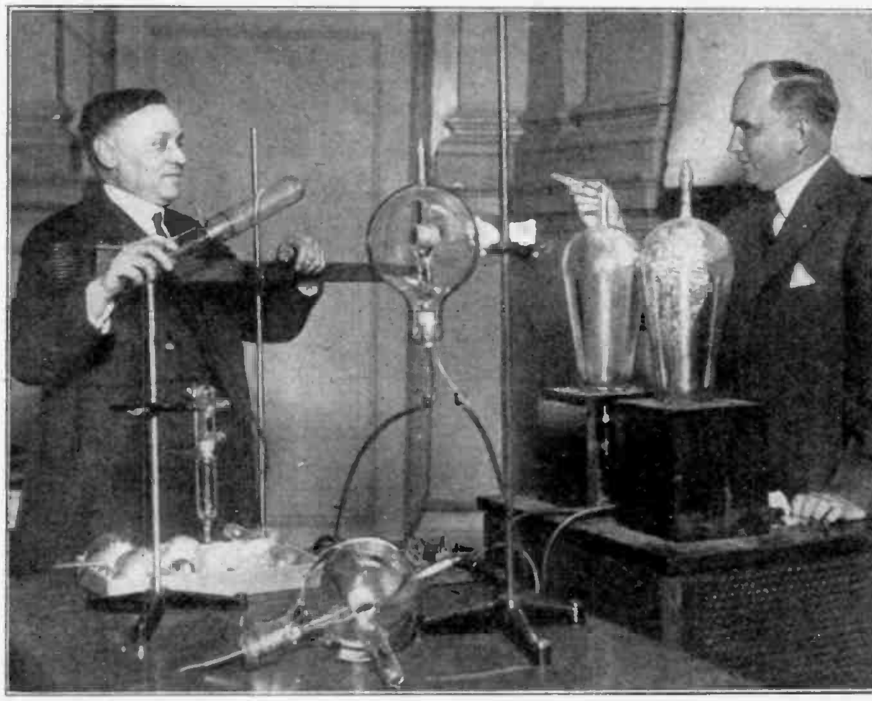
Scientist Has Key to Possible "Death Ray"

BEAMS of radio power, criss-crossing a city like searchlight rays and carrying light and power as wires do now, were discussed as future scientific possibilities, following spectacular demonstrations of present power transmission by radio shown by two Westinghouse engineers, Dr. Harvey C. Rentschler and Dr. Phillips Thomas, to the New York Electrical Society.

Electric lamps, held up by Dr. Thomas in air, glowed brightly although not wired to power wires. In a novel radio furnace displayed by Dr. Rentschler chemical reactions possible only in a vacuum were initiated by radio waves. A disk of metallic tungsten, among the most infusible of all metals, was heated white hot in an instant by the invisible rays.

That radio-power beams of a special variety might prove to be the long-imagined "death ray" was mentioned, not as a fantastic dream of some modern Jules Verne, but as a sober scientific possibility.

Radio waves like those used in broadcasting, except of shorter wavelength, can be reflected from metal mirrors to make narrow beams, like the beams from automobile headlights. Dr. Thomas generated before the Society waves of this type, not in beams but as short as 240 centimeters, or eight feet, which is only about one hundredth of the wavelength of the shortest waves ordinarily used in broadcasting.



(Wide World)

DR. HARVEY C. RENTSCHLER explains his radio furnace to S. P. Grace.

Grid Modulation Called Most Effective

(Concluded from preceding page)

of the detector. The plate return of the detector is connected to the high potential side of the oscillator tuned circuit, and the grid return of the oscillator is connected to the positive end of the filament battery. The normal plate voltage on the detector is then only 6 volts. But the voltage fluctuations across the oscillator tuned circuit are added to the normal voltage, and these fluctuations are quite large. Hence the effective plate voltage on the detector is fluctuating widely with a frequency equal to that of the oscillator. This causes detection or the production of an intermediate frequency. The effect, as was stated above, is not nearly so great as when a similar voltage is introduced into the grid circuit of the detector, but this is offset by the fact that the voltage impressed on the plate is many times greater.

In this case the interaction between the two tuned circuits is very small, since the tube intervenes between the two. Hence the loop tuner will not change the frequency of the oscillator even when the coupling between it and the plate circuit is great. The chief source of interaction in this case is direct coupling through the air between the loop and the oscillator coil. But this can always be eliminated or minimized. The main difficulty with this arrangement is that the normal plate voltage on the detector is not nearly high enough. The detector tube does not work efficiently.

Another Good Method

In Fig 5 is shown an arrangement in which this difficulty has been removed. The oscillator coil L1 is coupled to the plate circuit of the detector by means of the pick-up coil L2. The normal voltage on the detector can now be adjusted to the value which gives greatest detection efficiency, say 45 volts, or it may be made equal to the voltage given the oscillator tube, as has been done in the figure. Since there is no danger of getting too much interaction between the two tuned circuits in this case, the coupling between L1 and L2 can be made close, and L2 can be made a coil of a fairly high number of turns. This will increase the fluctuations of the plate voltage on the detector, hence increase the intermediate frequency output.

As in the previous case the main source of interaction between the two tuned circuits is through the air, which can always be avoided without incurring losses. To get the same efficiency in this case as in Fig. 1 the coupling in Fig. 5 between the coils L1 and L2 must be much greater than in the former case. It can be used without trouble. Both the tuned circuits in Fig. 5 can be grounded on one side so that body capacity effects will not be appreciable.

The Mysterious Loop Circuit of a "Super"

By Smedley Burt Walsh

Those who use Super-Heterodynes have noticed that the effect of the RF tuner is very small on local signals, whereas on distant stations it contributes considerably to the selectivity of the set. There are two reasons for this. First, direct pick-up of signals by the oscillator coil and wiring, on the local signals; and, second, overloading of the detectors, particularly the second detector, on local signals.

The explanation really lies in the properties of the detector tube. The voltage in the output is proportional to the square of the radio frequency imput voltage as long as the input is not large enough to overtax the detectors. Signals originating from distant stations are very weak. Not enough energy is picked up by the wiring and an untuned RF circuit effectively to operate the detectors. Hence it is necessary to tune very accurately to get any appreciable response. The energy picked up from the local stations is large and the input voltage is high enough even without any tuning in the RF circuit to tax the detectors to their limit. Tuning merely overloads the detectors without any increase in the signal strength. Hence it seems that the RF tuner is not selective on the local stations. The apparent lack of selectivity on the local stations can be removed by shielding the oscillator and the circuit wiring as a whole, and by limiting the energy that is passed on to the first detector. If this is kept down to the same level as the distant signal, the first tuner will be just as sharp on local and strong signals as it will on DX. When a loop is used to input the first detector it is very difficult to limit the signal strength on the detector. But when a radio frequency tube is used and when the loop is connected to that, the signal that is passed on to the detector can easily be limited. It can be done by throttling down the RF tube either in the filament circuit or in the plate.

Of course, when this is done it is necessary completely to shield the second tuner, that is, the one coupling the first tube to the detector, or this tuner will pick up enough energy entirely to upset the gain in selectivity.

A THOUGHT FOR THE WEEK

LEARNED radio engineers can tell you why, when or where the various parts of a set function. The average listener-in is satisfied so long as his set gets him what he wants, and is perfectly willing to let the scientific highbrows argue it out to their hearts' content. But the home constructor—well, that's different, and more power to his intelligent and inquiring mind.

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RADIO AS A HEALER

Reception Benefits to Blind and Deaf, and the Sick on Land or At Sea, Cited in WGBS Broadcast by Bernard

In one of his recent Friday night broadcasts from WGBS, the Gimble Bros. station in New York City, Herman Bernard, managing editor of Radio World, discussed radio as a healing agency. He said:

Radio as the source of entertainment, information and education in the home does the greatest good to the greatest number, and thus is indeed democratic in its good offices, but radio as an enspiriting agency for the afflicted does the greatest percentage of good for the individual. Thus able bodied citizens tuning in almost nightly, might have a benefit rating of 10 per cent, because they are among the greatest number, and the good that radio does is spread out among so many. But to the afflicted the radio benefit may run as high as 100 per cent.

For instance, take the case of a deaf person. Certainly if hearing can be restored to that soul who from the very day of birth has been denied the ability to detect sound, that would be a case of 100 per cent. benefit. It would represent one of the greatest blessings that radio can confer on any member of mankind, the restoration of a lost sense. Think with what a thrill Prof. A. E. Brooks, lately of the faculty of the University of Tennessee, must have risen from his chair when, trying to listen to the radio, he found that his recently acquired total deafness had disappeared!

Many Verified Instances

It is not true, of course, that any deaf person can have his or her hearing restored simply by having earphones clamped to the head. But it certainly is true that there are many verified instances where radio has been instrumental in causing totally lost hearing to be restored, and even of making natively deaf persons hear normally. Just how this is accomplished I do not know, but I have faith in the theory that the strong sound agitation set up by the earphones in a highly localized area provides the necessary impulses which sometimes—but unfortunately not always—stimulate the dormant nerves of hearing.

For the blind, radio has its blessings, too, if only in the fact that it can bring so much enjoyment to those denied the rich asset of sight. The broadcasting stations do so much to visualize orally and musically the scenes of the theme that the unsighted gain doubly from this preparation. Besides, the afflicted more keenly sense and interpret the oral equivalent of the visual, due to the protective sharpening of the other senses almost always found in any one at least minus one faculty. Thus the blind man may be expected to feel, hear, smell and taste much more discerningly than the person who possessses all five senses.

Great Service in Hospitals

In the hospitals radios serve a noble purpose. They cheer up patients and expedite convalescence. The radio has a definite psychological value that might almost be rated in medicinal or surgical equivalents. Many patients in hospitals would rather go without their breakfast than without their radio.

The hospital utilization of radio is almost unanimous in newly constructed hospitals and sanitariums. Even older ones are adapting their premises to installations. Under all these plans there is one master receiver on the premises, usually superintended by the stationary engineer, and all the patients who care to listen in will receive the same program. Of course the engineer may tune in any station within range. There is a socket in the wall into which earphones or speakers are plugged at will. Thus the long hours of the afternoon, when perhaps no visitors show up, are pleasantly whiled away, and, day or night, the patients get pretty much what they want in the way of programs, or, if they don't, they take the engineer sharply into their confidence. Sometimes a patient has a friend or relative who is broadcasting, and the engineer obligingly tunes in that broadcaster, just as Mr. H. J. B. LeTender, at the Park West, has tuned in WGBS tonight so that my mother on her hospital bed can listen to me.

Health Service Lauded

And in the alleviation of suffering let us not forget the great proven value of medical advice sent by radio code messages from Public Health Service stations of the United States Government to ships at sea that have sick folk but no physicians aboard. Many a life has been saved by that splendid radio consultation. Even medicines are prescribed or minor operations guided, for there is always some one aboard ship who is especially handy with the first-aid kit and can follow a doctor's explicit instructions.

And so, in the enjoyment of our radio let us not forget to assay the worth of radio to the afflicted in North or South, East or West, on land or at sea, be the sufferer royal or humble, rich or poor. For radio is not only a feat of science but one of the great merciful agencies of God.

Army Claims Credit For Single Wire Aerial

Army Signal Corps units operating radio stations in Cuba in 1908 used the single wire antenna, now recognized as the most effective, and probably were the first to make practical use of this antennae for transmission, it is recorded in a statement just issued by the Department of War. Ever since this first experiment, the statement said, the Signal Corps has placed dependence on single antennas for use with the field pack radio sets.

The full text of the statement follows:

"The recent widespread development of short wave (high frequency) radio, as well as the development of the modern broadcast receiving set, has made a single wire antenna the rule rather than the exception.

"In the early days of broadcasting it was considered desirable that antennas, either for reception or transmission, consist of several wires, but modern practice, even for transmission, especially for short wave, trends to use only a single wire.

"It is worthy of note that probably the first practical use of single wire antennas for transmission was made by Army Signal Corps units operating radio stations in Cuba in 1908, under Colonel John E. Hemphill, Signal Corps, now on duty in Washington. At that time single wires supported by box kites were tried, and with these the Army pack sets with only about 200 watts power, succeeded in communicating with the Naval Radio Station at Key West.

"Ever since the Army Signal Corps has placed great dependence on single wire antennas in connection with the field pack radio sets."

The claim was not disputed.

Esquimos Confounded By Radio's Versatility

Esquimos at Hudson Bay, having been told that their Bishop, the Rev. Turquetil, would broadcast in their own language, were very much confused. A short-wave set had to be used to pick up KDKA's special transmission, but they couldn't understand that, either.

Counting the time to elapse between the question and the broadcast, they asked: "How many sleeps yet to wait?" Another question was: "Where will he speak from?" It was answered by pointing to Pittsburgh on a map.

"How can this machine talk Esquimo?" one inquired. "How loud must he shout to be heard all the way up here?" another asked.

Sykes Is Glad 1-Man Control Doesn't Exist

Commissioner Eugene Sykes likes the idea of board responsibility for radio administration, rather than one-man control. He said:

It is, I think, a very fortunate thing that our plans, and their application to each special case, are not made by the law the duty of any one man. Here is a problem involving many millions of dollars invested in broadcasting equipment, half a billion dollars of annual sales of radio sets and supplies, and, by all odds most important, millions of American people in whose lives radio has come to play an established part. It is a problem which, as the result of the utterly unprecedented growth of the industry, is at present more perplexing than it has ever been before or, we sincerely hope, will ever be again.

You can readily see why this burden ought not to be laid on the shoulders of any one individual. Secretary-Hoover, who under the old law of 1912 had the undivided responsibility, has himself clearly realized this, and has been consistent in his opposition to the idea of one-man control.

The new law has created the Federal Radio Commission, its five members representing every section of the country. I know that I am speaking for my fellow commissioners as well as for myself when I say that we are approaching our task, in full recognition of its importance and magnitude, with the single purpose of carrying out both the letter and the spirit of the law.

We are under no obligations, political or otherwise, except to you, the radio public. We ask your help, and also, for awhile, we ask your patience. We want to act quickly, but we must act justly.

Tonight, on behalf of the Federal Radio Commission, I can make you only one promise, and that is that in everything we may do we are going to be guided by the spirit of the Federal law under which we hold office—the principle that the right to broadcast is dependent, not on selfish interest, but on service to the listening public—to you whom I have been privileged to address this evening.

Recorded Air Squeals Played Before Board

How squeals, caused by heterodyning stations in and about New York City, sound in a radio set, was recently demonstrated before the Federal Radio Commission on phonograph records sent to them by Eric H. Palmer, of New York. The records were made with a loop-operated receiver which was turned in all directions during the tests. Jack Binns aided in making the records. Palmer referred to the recording as a "symphony in squeals."

It was stated by Commissioner Caldwell that similar records will be sought from other cities, so that the Commission may have a complete record of the actual conditions.

BLIND PIANIST LEADS

Los Angeles.

The artist to receive the most telephone applause at the Los Angeles station of KHJ last month was William Sharp, blind pianist. Mr. Sharp, a student at the New England Convervatory of Music, is visiting Southern California. His renditions of classic solo numbers are declared to be exceptionally fine.

An Utopian Summer Foreseen By Caldwell

Washington.

"I am beginning to see daylight. I think we will have the broadcasting tangle straightened out before the Summer is over."

So said Commissioner Orestes H. Caldwell. He continued:

"When I first came here to take my job, I was puzzled and bewildered. It looked just like a vast swamp through which we would have to cut our way. Like a forest it seemed impenetrable at a distance. But when we got close to it, we saw it wasn't nearly so impossible as it appeared."

Commissioner Caldwell believes it will be possible for the Commission to take care of every station now in operation. But the extent to which the Commission will provide for each station will depend "precisely on the service rendered by the station and the necessity for its existence."

The Commission intends to give good waves to the stations which are rendering desirable service and poor waves around 210 meters to the others.

Here are some figures which have been presented to the Commission regarding the cost of installation and operation of various types of stations:

The cost of installation of a 10-watt station is $1,200. The annual upkeep cost of about $2,000.

The cost of installation of a 100-watt station is about $5,000. The annual upkeep is about $6,000.

The cost of installation of a 500-watt station is about $10,000. The annual upkeep is about $9,500.

The cost of installation of a 1,000-watt station is about $17,000. The annual operating expense is about $15,000.

The cost of installation of a 5,000-watt station averages between $60,000 and $100,000. The annual bill for upkeep ranges from $40,000 to $100,000.

Twenty-six Divide Time In N. Y. Area

Twenty-six stations in the Metropolitan District are now dividing time. These are shown in the following list of frequencies used by the 44 licensed stations in the district:

Kilocycles	Stations
1,460	WFRL
1,430	WMBQ
1,410	WKBO
1,370	WIBI-WJBI
1,340	WBMS
1,320	WMRJ-WLBH
1,300	WLBX
1,270	WAAT-WBOQ
1,250	WTRC
1,230	WGBB
1,210	WBRS-WBKN
1,190	WGCP-WARS
1,160	WWRL
1,140	WAAM-WSDA
1,120	WBBC
1,100	WEBJ-WPCH
1,070	WDWM-WLRL
1,040	WKBQ-WSOM
1,010	WODA-WBNY
990	WMSG
950	WABC-WGBS
930	WGL-WHAP
880	WMCA
830	WHN-WPAP
800	WRNY
780	WLWL
740	WOR
720	WBBR
660	WJZ
610	WEAF
570	WNYC

WABF Loses Permit

Washington.

The Federal Radio Commission just one week after it had granted a temporary operating permit to WABF, run by the Markle Broadcasting Company at Kingston, Pa., temporarily withdrew it. The station was found to be using the 730 kc. channel, assigned for the exclusive use of Canada. The station was ordered to specify another frequency.

Station WHAZ, at Troy, was ordered to reduce its power from 1,000 to 500 watts.

Colored Photographs Radioed Over U. S.

After more than a year's experimenting, the engineers of the American Telephone and Telegraph Company, have sent photos in which three or more colors are used by radio across the continent, and reproduced them with all their delicate shadings. The same method as employed in the transmitting of black and white photos is used.

The photo to be sent is provided as a negative on a glass plate in any size. A positive is then made on a celluloid film, five by seven inches. This is placed in a cylindrical frame in the transmitter. At the receiver, an unexposed film is placed on a similar frame. At a signal, both cylinders are started rotating simultaneously. Before the signal is started, special dark and light current adjustments are made. The complete transmission takes about seven minutes. Now when making the colored transmissions, three separate plates are used, if three colors are desired. A photograph is made of the print through screens, which filter out the color, so as not to be recorded on the plate. The color separation plates, at the present time, must be provided by the sender, the telephone company not having any provisions for this task, as yet. The time for this transmission depends upon the number of colors. New York, Boston, Atlanta, Cleveland, Chicago, St. Louis, Los Angeles and San Francisco are now provided with telephoto transmitting and receiving sets.

Those interested in the advance of styles, are especially interested in this system.

LARGER AERIAL FOR KHQ

Spokane, Wash.

Permission to erect an aerial from the south radio tower on the Payton building to the smokestack of the Davenport Hotel was granted to KHQ by the City Council. I. W. Chapman, for the station, said the aerial would insure better transmission of programs.

HAMILTON DIRECTS WOR

E. Paul Hamilton, an executive of L. Bamberger and Company, has been appointed managing director of WOR, the broadcasting station owned and operated by this company, which is located in Newark, N. J.

Radio University

A FREE Question and Answer Department conducted by RADIO WORLD for its yearly subscribers only, by its staff of Experts. Address Radio University, RADIO WORLD, 145 West 45th ST., New York City.

When writing for information give your Radio University subscription number

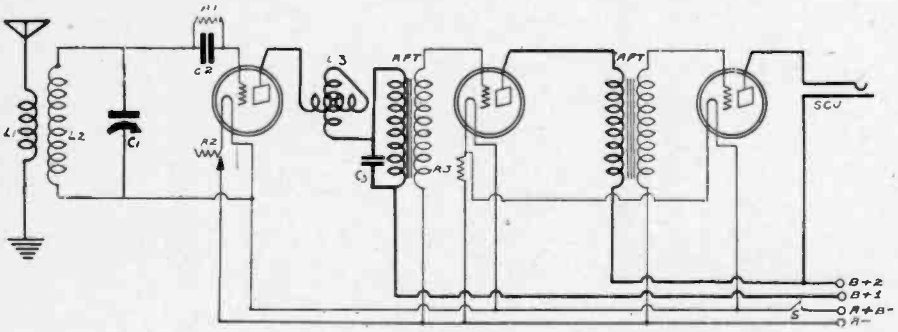

FIG. 533

The circuit diagram of a three-tube regenerative receiver, using Jackson Melwor's parts.

I HAVE the circuit diagram of a five-tube receiver in which one stage of tuned radio frequency amplification, a regenerative detector and three stages of resistance coupled audio frequency amplification are used. Instead of the output of the radio frequency tube being fed into the detector tube via the primary and secondary windings of the usual TRFT, it is connected up in impedance coupling fashion. Is this method better that the individual windings of a TRFT, on a circuit of this type? If not, please state how I may construct a coil to use here. The primary of the input RF transformer consists of fifteen turns, while the secondary consists of fifty turns. Both are wound on a three and one-quarter inch diameter tubing, with No. 22 double cotton covered wire. The plate coil in the detector circuit contains thirty-eight turns. would on a two-inch diameter form, with wire, that looks like No. 30 enameled. Across this a .00035 mfd. variable condenser is shunted.

(2)—What capacity variable condensers should be used?—EDWARD MARLOW, Atlantic City N. J.

(1)—The individual windings will give better results. A three and one-quarter inch diameter tubing should be used. The primary winding should consist of twelve turns. The secondary winding should consist of fifty turns. Use No. 22 double cotton covered wire. Space one-quarter inch.

(2)—Use .00037 mfd. variable condensers across the secondaries of the coils.

* * *

CAN A SIMPLE, yet efficient receiver be constructed from a coil having a ten-turn primary and a forty-five turn secondary, both wound on a three-inch diameter tubing with No. 22 double cotton covered wire; a variometer of the larger type; a pair of two-to-one ratio audio frequency transformers; a twenty-ohm rheostat; a 112 Amperite and a .0005 mfd. fixed condenser?

(2)—Please explain the hooking up of the coils, as well as the filament circuit.

(3)—Any other information would also be appreciated.—JACKSON MELWOR, Philadelphia, Pa.

(1)—The circuit diagram of a three-tube receiver using these parts is shown in Fig. 533. The variometer is connected in the plate circuit, and makes the set regenerative.

(2)—The beginning of the primary winding L1 is brought to the antenna. The end of this winding is brought to the ground. The beginning of the secondary winding (this point should be right next to the ground connection) is brought to the rotary plates of the .0005 mfd. variable condenser C1 and to the filament plus post on a socket. This same terminal is also connected to the plus filament post of the other two sockets. The lead is then connected to a terminal of a filament switch. The other terminal of this switch is then connected to the plus A, minus B post. Now the other terminal of the secondary winding (farthest away from the antenna post connection) is connected to the stationary plate post of the .0005 mfd. variable condenser C1 and to a terminal of a .00025 mfd. fixed condenser and a 2 megohm grid leak, C2R1. The other terminals of this combination are connected to the G post of this first socket. The plate post of this socket is brought to one terminal of the variometer, while the other terminal is brought to the P post on one transformer, as well as one terminal of the .0005 mfd. fixed condenser C3. The other terminal of this fixed condenser is brought to the B plus post of this transformer and to the B plus post. To this post the 45 volt post of the B battery is connected. The filament minus posts of the other two sockets are connected together and thence to one terminal of the 112 Amperite. The other terminal of the Amperite is brought to the minus A post. R2 is the rheostat.

(3)—A single-circuit jack is connected in the last audio output. Should you find it difficult to get the tube oscillating over the entire wavelength, first try increasing the resistance of the grid leak to 4 megohms. Then insert a .00025 mfd. fixed condenser across the variometer posts. Of course, increasing the plate voltage will also help. To the plates of the amplifier tubes apply 90 volts.

* * *

IN THE March 16 issue of RADIO WORLD on page 4 there appeared a circuit diagram of a six-tube receiver which I would like to construct. However, no data was given. Was this circuit ever described before. If so, please give the issue.—A. C. JEFFERY, Rushville, Ind.

The October 16 issue of RADIO WORLD contained complete data on this circuit.

* * *

IF I PLACE a .00025 mfd. variable condenser in series with the antenna circuit, do I have to increase the number of turns on the primary of the coil to prevent loss of volume? That is, if the primary of my coil contains ten turns, should I increase it to about fifteen?

ALEXANDER MEYERS. Boston, Mass.

Yes.

* * *

I WOULD like to know if RADIO WORLD ever published the Reinartz receiver for use on short waves, say on about forty meters. If so please give the issue.

DAVID GLASSER, Newark, N. J.

Yes, page 18 of the January 16, 1926 issue.

* * *

THE LOOP described by Herbert E. Hayden in the January 16, 1926 issue of RADIO WORLD has been built by a friend of mine. He. in turn, presented it to me. I have a five-tube receiver, employing the standard two tubed radio stages, a non-regenerative detector and two transformer stages. The capacities of the variable condensers used in this set are .0005 mfd. I would like to use this loop, but am puzzled as where to connect it. That is, is it necessary to connect up another tube, or can the present set be adapted for use with it? Please explain fully.

(2)—Is a ground necessary, when using this loop?—MICHAEL DRAPERS, Tarrytown, N. Y.

(1)—The loop can be used with your present set, but it will require some new leads. Use a double circuit jack, with loop terminals in a plug. The inside jack springs connect only to the secondary terminals of the first RF transformer.

(2)—No.

* * *

WHILE LOOKING over my old copies of RADIO WORLD, I noticed the one-tube set in the August 29 issue, described by Herbert E. Hayden. However, I would like to change it into a three-tube model. Before doing so, I would like the following queries answered:

(1)—Could an -00A tube be used as a detector and two -01A tubes as audio amplifiers?

(2)—Could I use a fifteen-ohm rheostat to control the detector filament and a 6-ohm rheostat for the audio filaments?

(3)—Will I get satisfactory results if I use ninety volts on the plate of the audio tubes?

(4)—Should I use a C battery?

(5)—Will a four-and-one-half volt type do?

(6)—Could I use a seven-inch high, eighteen-inch long cabinet?

EDGAR R. PIERCE, Los Angeles, Calif.

(1)—Yes. You will have to change the grid return on the detector circuit to minus A.

(2, 3, 4, 5 and 6)—Yes.

* * *

IN THE November 7, 1925 issue of RADIO WORLD on page 15 there appeared a circuit diagram of a three-stage audio amplifier, one transformer and two resistance coupled being used. I am going to build this amplifier, but would like to have a few pointers, before beginning construction.

(1)—A rheostat is now in the hookup. I have a one-quarter and a three-quarter ampere ballast resistor. Could I use the one quarter ballast to control the filament of a high-mu tube in the first audio circuit and a three-quarter ampere ballast to control the filaments of another high-mu and a 71 power tube?

HARRY L. BUEROD, Pittsburgh, Pa.

Yes. Be sure to apply the proper B and C voltages, as specified by the manufacturers on the tube cartons.

* * *

THERE APPEARED in the April 2 issue of RADIO WORLD in the Radio University columns a circuit diagram of a four-tube regenerative receiver which I have decided to build.

(1)—I would like to use two twenty-ohm and one six-ohm rheostats. The twenty-ohm rheostats are to be in the RF and detector circuits and the six ohm is to be in the audio circuit. Is this all right?

(2)—Can the set be put on a 7x18 inch panel?

MAX ZERWOFF, Portland, Ore.

(1)—Yes.

(2)—Yes.

* * *

REGARDING THE four-tube receiver described by Ludlow Greer in the January 29 issue of RADIO WORLD.

(1)—Where should the tapped coil L3

be placed on the mounting board?

(2)—What size cabinet can be used to house the set? Also state the baseboard size.

(3)—Could a loop be used?

(4)—Is CN variable? It seems to be indicated as a fixed condenser.

(5)—Could the last audio stage, which is now transformer coupled, be supplanted by two stages of resistance coupling, as in the Diamond? — IRVING GOLDENBERG, N. Y. City.

(1)—Parallel to the grid coil, about one inch away. You may also wind the coil so that it may be placed inside of the grid coil. Doing this will necessitate the use of a two-inch diameter tubing. Wind fifty turns, using No. 26 single silk covered wire, or enameled. Tap the coil at the twenty-fifth turn.

(2)—Use a seven by twenty-four-inch cabinet and panel. A twenty-one inch long, eight-inch deep baseboard should be used.

(3)—Not successfully.

(4)—Yes. It is so indicated in the text. See the second paragraph, last two lines.

(5)—Yes.

* * *

I HAVE built the five-tube receiver shown in the Radio University columns of the January 9 issue of RADIO WORLD, and with stations above 400 meters the results are excellent. Below that the tuning is very erratic, the set squealing a great deal. What can be done to cure the set of this trouble?

(2)—Could I insert a ½ ampere ballast to control the filaments of the two audio tubes, and a fifteen-ohm rheostat to control the filament of the detector tube?

(3)—Is it possible to use a C battery for both audio tubes? If so, how should it be connected?

(4)—Could I use a Bretwood Variable Grid Leak?

(5)—Could a pilot light be inserted, one terminal going to the plus A post and the other terminal going to the minus A post?—LEONARD SMITH, Kingston, N. Y.

(1)—Push the primary winding one-half inch away from the secondary windings. Decrease the number of primary turns on the second and third radio frequency transformers to seven. Increase the number of turns on the antenna primary by four turns or more. Run the ends of the primary windings of the second and third radio frequency transformers to a separate B plus post. To this post connect the sixty-seven and one-half volt post of the B battery. In series with this connection, insert a two thousand ohm variable resistance. Use this to decrease or increase the voltage on the plates of the radio frequency tubes.

(2)—Yes.

(3)—Yes. Break the leads of the F posts running to the minus A post. Connect these F posts together. Attach to this common lead, a flexible lead, attaching a cable marker, marked C minus, to it. Now procure a four and one-half volt C battery. Run the flexible lead to the minus post of this battery. Connect the plus post of this battery to the minus A post.

(4)—Yes. (5)—Yes.

WHEN TESTING a variable condenser in a circuit, for a short circuit, should the terminals of the testing unit (battery and phones) be brought to the rotary and stationary plates of the condenser while in the circuit, or should the connections in the set be broken, before testing?

(2)—When testing an audio transformer, should one hear a loud click when placing the testing clips across the primary and a softer one when placed across the secondary?

FRANK ILLWART, Providence, L. I.

(1)—You should disconnect a lead from the condenser, before testing. Otherwise you will have a complete circuit. This will cause a click to be heard and yet the condenser may be all right. An open circuit in the leads may however be determined with the leads connected to the condenser. (2)—Yes.

THE RADIO TRADE

Big Merger By Crosley Said to Be Imminent

Absorption of Small Companies Is Expected As Follow-Up of Recent Acquisition of De Forest Control

The Crosley Radio Corporation, of Cincinnati, is expected to absorb a number of smaller companies, the first step of which was said to be the gaining of financial control of the De Forest Radio Company.

Powel Crosley, Jr., president of the Cincinnati Company, has had virtually complete control of the De Forest Company since last Summer, when it failed and a receiver was appointed. Mr. Crosley advanced $300,000 for the company to continue business and was elected president. He also had granted to him complete charge of its affairs for five years through an agreement with the receiver, the trustees, and the courts.

Financial observers say the end of the period of rapid development and experimentation in the radio industry has almost been reached, and that with the industry on a more stabilized basis several financial readjustments are likely.

B. C. L. Expands

Due to the enormous growth of their business, B. C. L. Radio Service, formerly at 221 Fulton Street, New York City, on May 1 removed to larger quarters at 218-220-222 Fulton Street, across the street from the old quarters. This concern has exclusive rights to distribution on the "Diamond of the Air" kit.

This house will make a specialty of kits. All standard kits will be carried in stock. Another feature of their service will be an up-to-date repair and custom building department. Sets will be built to order. Sets, speakers and eliminators will be repaired. This service will also be available to mail order customers.

This concern has attained its eminent success under the guidance of Louis Lager, one of the pioneers in radio service of the modern kind, and well known to the trade at large.

Radio Kit Company

The Radio Kit Company has opened its new headquarters and laboratories at 72 Cortlandt Street, New York City. This concern is prepared to furnish kits for any known circuit. A separate laboratory service will be maintained for the benefit of customers and no charge for testing and inspection will be made. The laboratory service will be also available to non-customers for pay. E. Julian and E. B. Moore of the firm have had a long experience in radio.

BEN APLIN BUSY

Ben Aplin, Thordarson representative in New York, reports business never better. He says that the entire Thordarson line is in great demand. Mr. Aplin forsees the greatest radio year in history for next season and believes that the power supply business will be pre-eminent.

He is handling also a compact portable set that, with all equipment, weighs only 24 pounds. It is 12½" x 10" x 8½" over all. A circular may be obtained by writing to Ben J. Aplin, 30 Church Street, New York City.

NEW CORPORATIONS

Zelner Electric Co., N. Y. City, N. Y., radio, $10,000. (Atty., J. D. Belmont, 82 Wall St., N. Y. City, N. Y.)

Literature Wanted

THE names and addresses of readers of RADIO WORLD who desire literature on parts and sets from radio manufactures, jobbers, dealers and mail order houses are published in RADIO WORLD on request of the reader. The blank below may be used, or a post card or letter will do instead.

RADIO WORLD,
145 West 45th St., N. Y. City.

I desire to receive radio literature

Name ....
Address ....
City or town ....
State ....

Chas. E. Bish, Box 389, New Bethlehem, Pa.
Conrad Knapp, 216 North Second St., Missouri Valley, Ia.
A. J. Braekim, Itasco, Texas.
Charles Hughes, P. O. Box 121, O'Brien, Texas.
James Dirrim, 1693 East 9th St., Portland, Ore.
Dick Rief, R. D. 4, Tusc St., Extension E. Canton, O.
G. W. Law, 612 Houghton St., Rockford, Ill.
Anthony Bouza, Jr., 1590 2nd Ave., N. Y. City, N. Y.
J. E. Boyle, 1607 Brighton Road, Northside Pittsburgh, Pa.
D. W. Cook, 1037 15th St., Rock Island, Ill.
W. J. Moyer, 1717 North Shore Ave., Chicago, Ill.
H. C. True, 808 Alvarado St., San Francisco, Calif.
O. K. Stavenau, Orleans, Minn.
Rudolph H. Sjogren, 48 Everard St., Worcester, Mass.
W. P. Sommers, Metamora, Ill.
Harvey A. Kemper, 21 E. Louther St., Carlisle, Pa.
Lucien Denschenes, Trois Bistoles, Temiscouata, P. Q. Canada.
J. J. Bell, P. O. Box 302, Council Bluffs, Ia.
Clarence R. Pope, 173 North Ave., Plainfield, N. J.
Paul K. Croft, Box 799, State College, Pa.
C. E. Hartson, Room 102, Bristol Hotel, Rochester, N. Y.
William Hostler, 322 North 10th St., Pottsville, Pa.
William R. Harvey, 957 Oakdale Ave., Chicago, Ill.
Walter Fuirdich, 1301 North Illinois St., Bellville, Ill.
John V. Schreck, 35 S St., N. W., Washington, D. C.
James Izatt, 2601 Forest St., McKeesport, Pa.
D. A. Sullivan, 3113 Haverford Ave., Philadelphia, Pa.
Milton Weiler, 1420 Prospect Ave., Bx., N. Y.
E. W. Smedley, 1390 Mt. Elliot Ave., Detroit, Mich.
J. P. Harvey, Metamora, Ill.
W. T. Courtney, 1909 Erson Ave., Detroit, Mich.

J. L. Bernard Joins Isolantite Forces

J. L. Bernard, publicity man of the Radio Corporation of America, resigned to organize the J. L. Bernard Company, with headquarters in the Tribune Building, N. Y. City, to represent the Isolantite Company of America, in an engineering-sales capacity. Mr. Bernard will tell manufacturers how to simplify production problems and turn out better products.

Cabinet Pact Signed By Freed-Eisemann

The Caswell-Runyan Company, cabinet makers, of Huntington, Ind., and the Freed - Eisemann Radio Corporation, Brooklyn, N. Y., have signed contracts whereby the Caswell-Runyan Company is to manufacture radio cabinets exclusively for Freed-Eisemann. Freed-Eisemann will do the national advertising but Caswell-Runyan will sell direct to Freed-Eisemann distributors. Freed-Eisemann will supply the distributors with chasses to be mounted in the cabinets.

Consulting Specialist

Haskell A. Blair, one of the first to blaze the trail of radio improvement in that vital element, tone quality, has opened his own consulting laboratories at Room 301, 74 Cortlandt Street, New York City. Solving radio problems for manufacturers, experimenters and radio fans will be part of his service. Socket power devices, circuit improvements and acoustical problems will be tackled. Another department will specialize in custom- built sets for fans and experimenters. Mr. Blair has specialized in radio for many years and is widely known as the designer of the Blair Electric set and the Blair Resistance-coupled set. He is at present working on a new audio development which gives wonderful tone quality—J. H. C.

Push-Pull Output

(Concluded from page 11)

tage sufficient to overload one tube, by working it into one of the two bends in its curve, the second tube is working at its opposite bend, which results in the harmonics generated in the first tube being cancelled out by those generated in opposite phase in the second tube. This allows of a much greater applied input voltage, which means, simply, a far greater power output than could be obtained from either one tube alone, or the two tubes simply connected in parallel.

Several misconceptions are current concerning push-pull amplification which can well be corrected. A push-pull stage requires a special input and output transformer (an output choke could be used, with decreased efficiency, but some output coupling device *must* be used). A push-pull stage gives several times the energy handling capacity of the two tubes used, were they to be connected in parallel. The voltage amplification of the push-pull stage is approximately the gain of an ordinary tube and transformer.

Criterion of Performance

A push-pull stage will deliver at its output, in magnified form, exactly what was fed into it, assuming a flat frequency characteristic, and the tubes used to be adequate, but it *will not in itself* correct for distortion in previous stages, to any greater degree than any other amplifier. It will help to eliminate motorboating on a B power supply, since the plate current drawn by a push-pull stage remains substantially constant; whereas in an ordinary amplifier the stage plate current varies with the applied signal voltage. Thus, a B supply of very poor voltage regulation will operate a push-pull stage without distortion, while an ordinary stage operated from it would introduce very serious distortion due to B voltage fluctuation reacting on its own output, as well as on the balance of the receiver operated from the B supply.

A push-pull power stage can easily be incorporated in any existing receiver, or added to any set, either as a power amplifier stage alone, or incorporated with a B supply as a power pack, since high quality input and output transformers, marketed by Silver-Marshall, Inc., are now available. The diagram shows how such power amplifier may be hooked up, the filament power being supplied either from a battery or an AC step-down transformer. Using such a circuit with two 112 tubes, with B and C potential furnished by a 180 volt glow-tube eliminator, the same amplification, and far greater undistorted power output, may be obtained as with a 210 tube operated at 400 volts. The cost is far less and the safety factor, due to lower voltages is immeasurably greater.

Billion and a Half, Radio's 6-Year Record

Washington.

Frank D. Arnold, director of development, National Broadcasting Co., addressing the Rotary Club, said that the radio industry directly and indirectly gives employment to 300,000 persons, while 3,500 manufacturers, distributors and jobbers attend to the making and selling of radio sets and parts.

"In 1920 the annual sales of radio amounted to $2,000,000," Mr. Arnold told the Rotarians. "During 1926 the sales reached $500,000,000, while the total sales credited to the industry for the period 1920 to 1926 is $1,492,000,000—a billion dollar industry developed in six years.

"Out of 27,000,000 homes in the United States, 6,000,000 have radio receivers, leaving 21,000,000 homes yet to be equipped. Out of 950 broadcasting stations in the entire world, 732 are operated in the United States. Figuring an average of five listeners to a set there is a potential audience in the United States of 30,000,000 people within the sound of a human voice."

New Wire Resistors Have High Ohmage

It is now possible to obtain for commercial purposes wire-wound resistor units one-half inch in diameter, having a resistance of 25,000 ohms to the linear inch.

This is the first time that wire-wound resistors of this high value have been commercially practicable, according to D. J. Burns of the Ward Leonard Electric Company.

Mr. Burns stated that the difficulties in winding hundreds of feet of wire less than one-half as great in diameter as the human hair were considered unsurmountable by the electrical industry until radio came along and forced a new standard and necessity for high ohms in small spaces.

The new resistors running as high as 100,000 ohms on a four inch tube are of practical interest to eliminator manufacturers and radio experimenters as they dissipate far greater amounts of energy than do other types of resistors.

Like all Vitrohms, these new resistors are wire-wound on porcelain tubes and vitreous enamelled.

Thomas Quits Fada; Joins Freed-Eisemann

Leslie G. Thomas, heretofore in charge of production, manufacture and test in the F. A. D. Andrea, Inc., organization, manufacturers of Neutrodyne sets, has joined the Freed-Eisemann Radio Corporation at Brooklyn, to take charge of the plant.

Harry Dreyer, formerly research engineer of the Hazeltine Corporation, is now a member of the Freed-Eisemann technical organization.

Hahn Is New Head Of Amrad Company

MEDFORD HILLS, Mass.

The Amrad Corporation has undergone reorganization.

Major James E. Hahn, president of the DeForest Radio Corporation of Canada, vice-president of Keith, Ltd., assumes the presidency of the Amrad Corporation. Powel Crosley, Jr., is chairman of the board of the new company, and Albert B. Ayers assumes the duties of general sales manager.

The new Amrad line, shortly to be officially exhibited, will include six, seven and eight-tube licensed Neutrodyne Receivers, completely shielded, single control.

Freshman's Ingenuity

ONE OF the fleet of small trucks, employed by service men of Freshman receivers. The body, as will be seen, is designed like the latest 6-tube, 1-dial Freshman Masterpiece receiver, which has taken the country by storm.

Stark Is New Chief Of Crosley Advertising

Kimball H. Stark has been appointed advertising manager of the Crosley Radio Corporation. Mr. Stark has been actively employed in the radio industry for ten years. From March, 1917, to July, 1918, he was with DeForest Radio, Telephone and Telegraph Company in the factory and laboratory, working on vacuum tube pumps, which included the manufacture of both receiving and transmitting tubes.

K. H. Stark

From August, 1918, to September, 1919, he was with the Sperry Gyroscope Company, New York City, employed in radio engineering and test work in connection with Navy war-time receiving equipment, including special short-wave and special long-wave receivers and airplane radio transmitters.

From October, 1919, to January, 1920, he was with the Wireless Improvement Company, Jersey City, as a radio test engineer on special navy radio compass receiving equipment.

In January, 1920, he returned to the Sperry Gyroscope Company as a radio engineer, in charge of test of special navy compass equipment, including experimental and design work.

March 1, 1921, he joined F. A. D. Andrea, Inc., New York City. For three years Mr. Stark was chief engineer for Fada. In addition to these duties, he managed the advertising and sales departments. In June, 1926, Mr. Stark had charge of purchase, inventory and production control, including the organization of statistical methods of the Charles Freshman Company, New York.

Socket Power Title Called Inadequate

According to A. Eisemann, of the Freed-Eisemann Radio Corporation, the term "socket power," officially adopted by the Radio Division of the National Electric Manufacturing Association, does not truly define radio sets operated from power supplied by the house lighting mains.

"When the Radio Division of the Association adopted the new word," said Mr. Eisemann, "it evidently omitted to note the necessity for a distinction between the so-called electrified sets which use the house lighting socket as a source of current to supply batteries fitted with trickle chargers and B and C eliminators. A distinction is necessary because there has been developed a truly electric set which derives its current supply directly from the house lighting mains without the interposition of such accessories as a trickle-charger and current supply devices. The electric set operating without battery eliminators will be next seasons feature in radio."

Baker Shares Time With Manufacturers

There has been a growing feeling among executives of the radio industry that the two basic branches of the industry, broadcasting and manufacturing, must be brought into permanent coordination in some manner. To that end L. S. Baker, executive secretary of the Broadcasters' Association, has been elected executive vice-president of the Radio Manufacturers Association. Mr. Baker will continue as the executive secretary of the Broadcasters Association.

Mendoza's Unit Rises To Symphonic Size

The Capitol Grand Orchestra, conducted by David Mendoza, has been enlarged to symphonic proportions. It is heard every Sunday night through WEAF and its network of stations in the broadcast of the program from the Capitol Theatre, New York City. Major Edward Bowes, managing director of the Capitol, is the announcer during the Capitol program.

DAVID MENDOZA

Suspension Threatened To Canadian Pirates

Washington.

Steps have been taken by the Canadian radio authorities to prevent stations in Canada from operating on any of the 89 wavelengths assigned to the stations in the United States. Six exclusive waves are allowed in Canada and twelve others are shared with the United States. Immediate suspension of license will be the punishment to any station caught pirating an American wavelength. Circulars are being distributed to all inspectors and supervisors containing this ruling. The thought that there was a disagreement between the American and Canadian governments on the channel situation, which would entitle the Canadian stations to use any wave they desired, is being rapidly dispelled through a specific denial entered on the circular.

New Electric Receiver Made for Hospitals

Joseph D. R. Freed announced that a radio set especially designed for use in hospitals and other institutions is now being built by the Freed-Eisemann Radio Corporation. This new receiver will be a portable, complete in itself, having a concealed loop within the cabinet.

"This hospital radio will give great pleasure to those who are shut in, make it possible for them to attend religious services and share the great musical programs now being broadcast," said Mr. Freed. "It is only necessary to disconnect it from the light socket and the set may be moved about on its own wheels."

Klosner Separator

The Klosner Radio Corporation, 1022 East 178th street, New York City, makers of rheostats, potenteometers and X type sockets, are now also manufacturing a device known as a station s-e-p-a-r-a-t-o-r. The instrument improves the selectivity of the receiver. There are no tuning controls on this device. It is only necessary to connect it in series with the antenna, and then tune the set in the regular way. It is especially effective on the lower waves. A switch is provided for short-circuiting it. The device is very compact and attractive.

BETTER MUSIC PREFERRED

Chicago.

Radio has greatly increased the desire for better music, according to delegates to the fifteenth biennial convention of the National Federation of Musical Clubs, which was recently held in this city.

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